IEEE CONTROL SYSTEMS SOCIETY TECHNICAL COMMITTEE ON DISCRETE EVENT SYSTEMS

Newsletter..... October 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/

Contents:

1. Editorial

2. Recent Activities of the CSS
2.1 Sponsored Activities
2.2 Technically Co-Sponsored activities

3. Journals
3.1 Selections from the IEEE Transactions on Automatic Control Volume: 61, Issue: 10, October 2016
3.2 Selections from Automatica Volume: 72, October 2016
3.3 Selections from the Asian Journal of Control Volume: 18, Issue: 5, September 2016
3.4 Selections from the Information Science Volume: 363, October 2016 (Special section on Deadlock analysis and control in resource allocation systems)

Editorial

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

Personal note from the editor:

WELCOME TO THE OCTOBER 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 (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/

Selections of Journal Publications

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

SELECTIONS OF THE IEEE TRANSACTIONS ON AUTOMATIC CONTROL
VOLUME: 61 ISSUE: 10
OCTOBER 2016

(1) Formal Verification of Stochastic Max-Plus-Linear Systems

Author: Sadegh Esmaeil Zadeh Soudjani, Dieky Adzkiya and Alessandro Abate

Abstract

This work investigates the computation of finite abstractions of Stochastic Max-Plus-Linear (SMPL) systems and their formal verification against general bounded-time linear temporal specifications. SMPL systems are probabilistic extensions of discrete-event MPL systems, which are widely employed for modeling engineering systems dealing with practical timing and synchronization issues. Departing from the standard existing approaches for the analysis of SMPL systems, we newly propose to construct formal, finite abstractions of a given SMPL system: the SMPL system is first re-formulated as a discrete-time Markov process, then abstracted as a finite-state Markov Chain (MC). The derivation of precise guarantees on the level of the introduced formal approximation allows us to probabilistically model check the obtained MC against bounded-time linear temporal specifications (which are of rather general applicability), and to reliably export the obtained results over the original SMPL system. The approach is practically implemented on a dedicated software and is elucidated and run over numerical examples.

Full-text available at: http://ieeexplore.ieee.org/document/7335578/

(2) Quantitative Supervisory Control Game for Discrete Event Systems

Author: Sasinee Pruekprasert, Toshimitsu Ushio and Takafumi Kanazawa

Abstract

We formulate an optimal supervisory control problem for quantitative non-terminating discrete event systems (DESs) modeled by finite weighted automata. The control performance of a supervisor is evaluated by the worst-case limit-average weight of the infinite sequences generated by the supervised DES. An optimal supervisor is a supervisor that avoids deadlocks and maximizes the control performance. We propose a game theoretical design method for an optimal supervisor using a two-player turn-based mean-payoff game automaton. As the first player, the objective of the supervisor is to maximize the worst-case limit-average weight of the generated sequences; as the second player, the DES aims to minimize it. We show that an optimal supervisor can be computed from an optimal strategy (of the first player) for this game. Then, we propose an algorithm to compute an f-minimally restrictive optimal supervisor, which is a finite-memory optimal supervisor that enables as many sequences as possible and can be represented by an optimal strategy for a finite version of the two-player game.

Full-text available at: http://ieeexplore.ieee.org/document/7369945/

(3) State Classification of Time-Nonhomogeneous Markov Chains and Average Reward Optimization of Multi-Chains

Author: Xi-Ren Cao

Abstract

In a discrete time nonhomogeneous Markov chain (TNHMC), the states spaces, transition probabilities, and reward functions at different times may be different. In this paper, with the confluencity previously introduced, we show that the states of a TNHMC can be classified into the branching states and a number of classes of confluent states (versus the transient and recurrent states in the time homogeneous case). The optimization of average reward in TNHMC's consisting of a single confluent class (uni-chain) have been addressed in a previous paper by the author. In this paper, we show that with confluencity and the state classification and under some bound conditions, we can obtain the necessary and sufficient conditions for optimal policies of the average reward of TNHMCs consisting of multiple confluent classes (multi-chains). Just like in the uni-chain TNHMC case, the sufficient condition does not need to hold in any "zero frequently visited" time sequence. This "under-selectivity" makes the problem not amenable to dynamic programming. A direct comparison based approach is used to prove the results. The results enhance our understanding of state classification and performance optimization with the notion of confluencity.

Full-text available at: http://ieeexplore.ieee.org/document/7355322/

(4) Finding Optimal Observation-Based Policies for Constrained POMDPs Under the Expected Average Reward Criterion

Author: Xiaofeng Jiang, Hongsheng Xi, Xiaodong Wang and Falin Liu

Abstract

In this technical note, constrained partially observable Markov decision processes with discrete state and action spaces under the average reward criterion are studied from a sensitivity point of view. By analyzing the derivatives of performance criteria, we develop a simulation-based optimization algorithm to find the optimal observation-based policy on the basis of a single sample path. This algorithm does not need any overly strict assumption and can be applied to the general ergodic Markov systems with the imperfect state information. The performance is proved to converge to the optimum with probability 1. One numerical example is provided to illustrate the applicability of the algorithm.

Full-text available at: http://ieeexplore.ieee.org/document/7317752/

==========

==========
==========
SELECTIONS OF AUTOMATICA
VOLUME: 72
OCTOBER 2016

(1) Finite-horizon Gaussianity-preserving event-based sensor scheduling in Kalman filter applications

Author: Junfeng Wu, Xiaoqiang Ren, Duo Han, Dawei Shi and Ling Shi

Abstract

This paper considers a remote state estimation problem, where a sensor measures the state of a linear discrete-time system. The sensor has computational capability to implement a local Kalman filter. The sensor-to-estimator communications are scheduled intentionally over a finite time horizon to obtain a desirable tradeoff between the state estimation quality and the limited communication resources. Compared with the literature, we adopt a Gaussianity-preserving event-based sensor schedule bypassing the nonlinearity problem met in threshold event-based polices. We derive the closed-form of minimum mean-square error (MMSE) estimator and show that, if communication is triggered, the estimator cannot do better than the local Kalman filter, otherwise, the associated error covariance, is simply a sum of the estimation error of the local Kalman filter and the performance loss due to the absence of communication. We further design the scheduler’s parameters by solving a dynamic programming (DP) problem. The computational overhead of the DP problem is less sensitive to the system dimension compared with that of existing algorithms in the literature.

Full-text available at:
http://www.sciencedirect.com/science/article/pii/S0005109816301984

(2) Iterative learning control for discrete-time systems with event-triggered transmission strategy and quantization

Author: Wenjun Xiong, Xinghuo Yu, Ragini Patel and Wenwu Yu

Abstract

This paper investigates the iterative learning problem for discrete-time systems with event-triggered scheme and quantization. The event-triggered scheme is firstly considered in the iterative learning controllers to reduce the number of

iteration steps to be updated. Here, the event-triggered scheme is designed depending on time t and iterative learning step k. Quantization is then introduced in the event-triggered controllers and some relaxed conditions are presented to guarantee the tracking problem by using some interval matrix properties. Finally, simulation results are given to illustrate the usefulness of the developed criteria.

Full-text available at:
http://www.sciencedirect.com/science/article/pii/S0005109816302266

==========

==========

SELECTIONS OF ASIAN JOURNAL OF CONTROL
VOLUME: 18 ISSUE: 5
SEPTEMBER 2016

(1) Existence and Verification for Decentralized Nondeterministic Discrete-Event Systems Under Bisimulation Equivalence

Author: Fuchun Liu, Rui Zhao, Taizhe Tan and Qiansheng Zhang

Abstract

In this paper, we study the decentralized control problem for nondeterministic discrete-event systems (DESs) under bisimulation equivalence. In order to exactly achieve the desired specification in the sense of bisimulation equivalence, we present a synchronous composition for the supervised system based on the simulation relation between the specification and the plant. After introducing the notions of simulation-based controllability and simulation-based coobservability, we present the necessary and sufficient condition for the existence of a decentralized supervisor such that the controlled system is bisimilar to the specification, and an algorithm for verifying the simulation-based coobservability is proposed by constructing a computational tree.

Full-text available at:
http://onlinelibrary.wiley.com/doi/10.1002/asjc.1253/full

==========

==========
SELECTIONS OF INFORMATION SCIENCE
VOLUME: 363 (Special section on Deadlock analysis and control in resource allocation systems)
OCTOBER 2016

(1) A novel method for deadlock prevention of AMS by using resource-oriented Petri nets

Author: Hefeng Chen, NaiQi Wu and MengChu Zhou

Abstract

Based on the systems of simple sequential processes with resources (S3PR) model, the existing methods involve prohibitive computation to synthesize a deadlock prevention controller for automated manufacturing systems (AMS). To reduce the computation, this work studies this problem by using a resource-oriented Petri net (ROPN) model. By revealing the relationship between the bad markings and structural properties of an ROPN, it presents a method such that a deadlock prevention controller can be obtained by simple calculation. By such a controller, for each strongly connected subnet in an ROPN, only one control place is needed such that it is structurally very simple. Furthermore, a condition is given under which a maximally permissive controller can be efficiently obtained, which was never seen before. Examples are used to show the application and performance of the proposed method.

Full-text available at:
http://www.sciencedirect.com/science/article/pii/S0020025515005915

(2) Complexity of the deadlock problem for Petri nets modeling resource allocation systems

Author: Guanjun Liu

Abstract

Petri nets are widely used to model and analyze Resource Allocation Systems (RASs). Since they are a kind of structuralized formal method, they can well describe the allocation/release of resources and their markings can directly reflect whether an RAS enters a (partial) deadlock caused by misallocating resources. In general, the key step of preventing/avoiding deadlocks is to decide if deadlocks occur or not in an RAS. This paper is about the complexity of deciding the deadlock problem

for Petri nets modeling RAS. We define a very general class of Petri nets called Petri Nets of Resource Allocation (PNRA) to model as many RASs as possible. PNRAs not only focus on the resources shared by processes also pay attention to the interaction/collaboration among processes. We show that the deadlock problem is PSPACE-complete for PNRAs. This paper also proves that for the well-known G-system as a subclass of PNRAs, the deadlock problem is NP-complete.

Full-text available at:
http://www.sciencedirect.com/science/article/pii/S002002551500835X

(3) A survey of siphons in Petri nets

Author: GaiYun Liu and Kamel Barkaoui

Abstract

Petri nets have gained increasing usage and acceptance as a basic model of asynchronous concurrent systems since 1962. As a class of structural objects of Petri nets, siphons play a critical role in the analysis and control of systems modeled with Petri nets. This paper surveys the state-of-the-art siphon theory of Petri nets including basic concepts, computation of siphons, controllability conditions, and deadlock control policies based on siphons. Some open problems on siphons are discussed, such as the maximally permissive supervisor design problems based on siphons and the application of siphons to robust supervisory control. This survey is expected to serve as a reference source for the growing number of Petri net researchers and practitioners.

Full-text available at:
http://www.sciencedirect.com/science/article/pii/S0020025515006258

(4) Design of optimal Petri-net controllers for a class of flexible manufacturing systems with key resources

Author: Huixia Liu, Weimin Wu, Hongye Su and Zhenxing Zhang

Abstract

Based on Petri net models, this work aims to address deadlock prevention problem for a class of flexible manufacturing systems (FMSs), which can be modeled by systems of simple sequential processes with resources (S3PRs). In an S3PR, a ξ-resource is a resource with unit capacity shared by two or more maximal perfect resource transition circuits (MPRT-circuits) that do not contain each other. For S3PRs without ξ-resources, the optimal Petri net-based polynomial complexity deadlock avoidance policies are synthesized in the previous work. This work focuses

on the design of optimal Petri net controllers for S3PRs with ξ-resources. First, the concepts of key resources and key transitions are introduced. A key resource is a special ξ-resource. If there is a key transition in an S3PR, there is a key resource in it, but not vice versa. For S3PRs with key resources, if there is no key transition in them, optimal Petri net controllers are synthesized; if there exist key transitions in them, it proves that when these nets are maximally permissive controlled (called as first-controlled), key transitions can result in the occurrence of deadlock phenomena (called as secondary-deadlock) in the controlled nets. Second, for S3PRs with key resources that contain key transitions and satisfy the Key-condition, secondary-deadlocks can be characterized by maximal perfect control transition circuits (MPCT-circuits) that are saturated at some reachable markings of their first-controlled systems. Then, by adding a control place and related arcs to each MPCT-circuit, secondary-deadlocks can be prevented and optimal Petri net controllers are designed for S3PRs with key resources that satisfy the Key-transition. Thereby, an optimal deadlock control policy for a class of FMSs with key resources is synthesized. Finally, a few examples are provided to demonstrate the presented policy.

Full-text available at:
http://www.sciencedirect.com/science/article/pii/S0020025515008312

(5) Think-globally-act-locally approach with weighted arcs to the synthesis of a liveness-enforcing supervisor for generalized Petri nets modeling FMSs

Author: Murat Uzam, Gökhan Gelen and Tahir Lawan Saleh

Abstract

This paper proposes a general approach, called a think-globally-act-locally method with weighted arcs (TGALW), which can be used to compute a liveness-enforcing supervisor (LES) for the Petri net (PN) model of a flexible manufacturing system (FMS) prone to deadlocks. Compared with siphon-based deadlock prevention policies that are usually rather conservative, the method is especially effective for generalized PN classes such as S4R and S4PR and also leads to optimal or near optimal LESs while maintaining the necessary computations simple. An original PNM is first transformed into a net that is behaviorally equivalent to it. A global sink/source place (GP) is used temporarily in the design steps and is finally removed when the liveness of the system is achieved. At each iteration step, bad markings are identified and then controlled by monitors through an established place-invariant based method. A condition of the optimal controllability of a bad marking is proposed, i.e., if all bad markings are optimally controlled at each iteration step, the TGALW method can find an optimal LES. Redundancy of monitors is checked. Typical examples existing in the literature are used to demonstrate applicability and the effectiveness of the proposed method.

Full-text available at:
http://www.sciencedirect.com/science/article/pii/S0020025515006647

(6) Optimal supervisor synthesis for petri nets with uncontrollable transitions: A bottom-up algorithm

Author: Shouguang Wang, Dan You and Chengying Wang

Abstract

Petri nets are a widely used tool to model, analyze and control discrete event systems that arise from automated production, intelligent transportation, and workflow management. For a class of Petri nets with uncontrollable transitions, this paper proposes a bottom-up algorithm to transform a given generalized mutual exclusion constraint into an optimal admissible one. Based on the transformation, a design method is proposed to synthesize an optimal supervisor. Compared with the existing methods that require the computation of exponential complexity, the proposed one can obtain an optimal supervisor with polynomial complexity.

Full-text available at:
http://www.sciencedirect.com/science/article/pii/S0020025515007835

(7) Model checking Petri nets with MSVL

Author: Ya Shi, Cong Tian, Zhenhua Duan and Mengchu Zhou

Abstract

This paper presents three translations from Petri nets to Modeling, Simulation and Verification Language (MSVL) programs. Each translation is directed by one of the three semantics of Petri nets, namely interleaving, concurrency and max-concurrency. Further, for each translation, an equivalence relation between Petri nets and generated MSVL programs is proved. As a result, the supporting tool MSV for MSVL can be used to verify the properties of Petri nets. Case studies are given to show how to do so with MSV under each semantics.

Full-text available at:
http://www.sciencedirect.com/science/article/pii/S0020025516000475

(8) Sequential composition of linear systems' clans

Author: Dmitry Zaitsev

Abstract

When using Petri nets to investigate deadlock control, structural analysis techniques are applied, which are based on solving systems of linear algebraic equations. To gain an extra computational speed-up when solving sparse linear systems, we examine a sequential clan-composition process, represented by a weighted graph. The system decomposition into clans is represented by a weighted graph. The comparative analysis of sequential composition for subgraphs and edges (pairwise) is presented. The task of constructing a sequence of systems of lower dimension is called an optimal collapse of a weighted graph; the question whether it is NP-complete remains open. Upper and lower bounds for the collapse width, corresponding to the maximal dimension of systems, are derived. A heuristic greedy algorithm of (quasi) optimal collapse is presented and validated statistically. The technique is applicable for solving sparse systems over arbitrary rings (fields) with sign.

Full-text available at:
http://www.sciencedirect.com/science/article/pii/S0020025516300706

==========
==========