IEEE CONTROL SYSTEMS SOCIETY TECHNICAL COMMITTEE ON DISCRETE EVENT SYSTEMS

Newsletter..... February 2017

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/ <http://www3.nd.edu/~hlin1/>

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Editorial

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

Activities

2.1 Sponsored Activities

2017 American Control Conference
Seattle, United States, May 24 - May 26, 2017
http://acc2017.a2c2.org/

2017 Conference on Control Technology and Applications
Kohala Coast, United States, Aug 27 - Aug 30, 2017
http://ccta2017.ieeecss.org/

2017 Conference on Decision and Control
Melbourne, Australia, Dec 12 - Dec 15, 2017
http://cdc2017.ieeecss.org/

2.2 Technically Co-Sponsored activities

The 36th Chinese Control Conference
Dalian, China, Jul 26 - Jul 28, 2017
http://ccc2017.dlut.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/

2017 Indian Control Conference
Guwahati, India, Jan 4 - Jan 6, 2017
http://icc.org.in/

6th International Conference on Systems and Control (ICSC 2017)
Batna, Algeria, May 7 - May 9, 2017
http://lias.labo.univ-poitiers.fr/icsc/icsc2017/

The 6th International Symposium on Advanced Control of Industrial Processes (AdCONIP 2017)
Taipei, Taiwan, May 28 - May 31, 2017
http://www.adconip2017.org/

2017 International Conference on Unmanned Aircraft Systems (ICUAS'17)
Miami, United States, Jun 13 - Jun 16, 2017
http://www.uasconferences.com/

IEEE CASE 2017, the 13th IEEE International Conference on Automation Science and Engineering
Xi'an, China, August 20-23, 2017
http://www.case2017.org

Selections of Journal Publications

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

SELECTIONS OF THE IEEE TRANSACTIONS ON AUTOMATIC CONTROL
VOLUME: 62 ISSUE: 2
February 2017

(1) Transient Analysis of Serial Production Lines With Perishable Products: Bernoulli Reliability Model

Author: Feng Ju, Jingshan Li, John A. Horst

Abstract

Manufacturing systems with perishable products are widely observed in practice (e.g., food industry, biochemical productions, battery and semiconductor manufacturing). In such systems, the quality of the product is highly affected by its exposure time while waiting for the next operation, i.e., the residence time of intermediate parts within the system. Such a time should be strictly limited in order to ensure the product usability. The parts that reach the maximum allowable residence time need to be scrapped, thus impeding the production. To achieve an efficient production, the time-dependent or transient analysis is important to uncover the underlying principles governing production operations. In this paper, a serial production line model with two Bernoulli reliability machines, a finite buffer and perishable products is presented to analyze the transient behavior of such systems. The analytical formulas are derived to evaluate transient performance, and structural properties are investigated to study the effect of system parameters. In addition, using the model, we address problems of settling time estimation and production control to demonstrate the importance of the proposed method for transient analysis.

Full-text available at: http://ieeexplore.ieee.org/document/7478055/

(2) Relative Time and Stochastic Control With Non-Smooth Features

Author: Xi-Ren Cao

Abstract

The stochastic calculus of non-smooth functions indicates that for a continuous semi-martingale X(t), the changes of a function h[X(t)] at its semi-smooth point (both right- and left-hand side derivatives exist) X(t)=x in [t,t+dt] is at the scale of the local time of X(t), with a mean of the order dt in the case of Ito processes. We introduce the relative time which evolves at the scale of local time when the semi-martingale is at a semi-smooth point of h(x). The change of h[X(t)] in [t,t+dt] can be precisely measured in the scale of relative time, while this change is wrongly ignored with regular time scale dt. The optimal control problem is well defined with the regular time replaced by the relative time; however, dynamic programming does not seem work well for this problem. We apply the direct-comparison-based optimization approach to the control problem formulated in relative time and derive the generalized Hamilton-Jacobi-Bellman (HJB)

equations, which consist of two parts, the classical HJB equation for smooth points, and some additional relations for semi-smooth points. Under some bounded conditions, the optimal value function is the (classical) solution to the generalized HJB equations, and viscosity solution is not needed. In addition, we show that the singular control problem can be formulated and solved in the same framework with the relative time.

Full-text available at: http://ieeexplore.ieee.org/document/7473931/

(3) Invariant-Based Supervisory Control of Switched Discrete Event Systems

Author: Spyros Reveliotis, Zhennan Fei

Abstract

This technical note introduces the notion of switched Discrete Event Systems (s-DES) and investigates its representational and computational potential in (i) the description and the analysis of the underlying DES behavior, (ii) the specification of the posed control requirements, and (iii) the eventual computation of the necessary control function. More specifically, it is shown that the potential decomposition of the overall DES behavior in a well defined set of “operational modes” enables the specification of control requirements and the synthesis of the corresponding control laws in a modular and distributed manner that takes full advantage of the aforementioned decomposition. The work is motivated by the need to cope with DES operating under a number of failing modes that result from non-catastrophic failures and repairs, and also DES that might evolve their operation through a number of “stages.” Furthermore, the technical developments of the technical note and their representational and computational power are further highlighted by an application example that is drawn from the area of robot pursuit on time-varying graphs; however, due to space considerations, this example is provided in an electronic supplement to the technical note.

Full-text available at: http://ieeexplore.ieee.org/document/7462240/

(4) Local Modular Supervisory Control of Timed Discrete-Event Systems

Author: Germano Schafaschek, Max H. de Queiroz, José E. R. Cury

Abstract

This note presents a local approach for the modular supervisory control of timed discrete-event systems. Our modular supervisors are designed over local models, which are obtained by aggregating only the subsystems affected by each control specification. We establish necessary and sufficient conditions for nonblocking

optimal global behavior. We also present a comparative analysis of the computational advantages and limitations of the proposed strategy.

Full-text available at: http://ieeexplore.ieee.org/document/7468518/

(5) Characterizing Token Delays of Timed Event Graphs for K- Cyclic Schedules

Author: Tae-Eog Lee, Hyun-Jung Kim, Dong-Hyun Roh, Ramavarapu S. Sreenivas

Abstract

A timed discrete event system, which repeats identical work cycles, has task delays due to synchronization between work cycles. Real such systems tend to operate mostly in a K- cyclic timing regime, where a sequence of identical timing patterns is repeated for every K cycles. Therefore, the task delays fluctuate and repeat a sequence of K different values, and hence have higher risk of violating an upper limit. Task delays correspond to token delays at the system's timed event graph model. We therefore examine token delays in K- cyclic schedules of a timed event graph, an essential class of Petri nets. We first identify all possible K- cyclic schedules and define their initial phases. We then develop a closed-formula on the token delays on a path for a K- cyclic schedule, which can be computed by the longest path lengths between the nodes in an associated directed graph. We also present a formula for 1-cyclic schedules. The formulae can be used for computing statistics on K- different token delays, maximizing or minimizing the token delays with regard to all possible initial phases, and verifying task delay constraints, if any.

Full-text available at: http://ieeexplore.ieee.org/document/7470632/

(6) Supervisory Control for Behavior Composition

Author: Paolo Felli, Nitin Yadav, Sebastian Sardina

Abstract

We relate behavior composition, a synthesis task studied in AI, to supervisory control theory from the discrete event systems field. In particular, we show that realizing (i.e., implementing) a target behavior (e.g., a house surveillance system) by suitably coordinating a collection of available behaviors (e.g., doors, lights, cameras, etc.) amounts to imposing a supervisor onto a special discrete event system. Such a link allows us to leverage on the solid foundations and extensive work on discrete event systems, including borrowing tools and ideas from it.

Full-text available at: http://ieeexplore.ieee.org/document/7473906/

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SELECTIONS OF AUTOMATICA
VOLUME: 76
February 2017

(1) Compositional synthesis of supervisors in the form of state machines and state maps

Author: Sahar Mohajerani, Robi Malik, Martin Fabian

Abstract

This paper investigates the compositional abstraction-based synthesis of least restrictive, controllable, and nonblocking supervisors for discrete event systems that are given as a large number of finite-state machines. It compares a previous algorithm that synthesises modular supervisors in the form of state machines, with an alternative that records state maps after each abstraction step and uses these to control the system. The state map-based algorithm supports all abstraction methods used previously, and in addition allows for nondeterminism, hiding, and transition removal. It has been implemented in the software tool Supremica and applied to several large industrial models. The experimental results and the complexity analysis show that state maps can be computed efficiently and in many cases require less memory than state machine-based supervisors.

Full-text available at:
http://www.sciencedirect.com/science/article/pii/S0005109816304046

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SELECTIONS OF DISCRETE EVENT DYNAMIC SYSTEMS: THEORY AND APPLICATIONS
VOLUME: 27 ISSUE: 1
March 2017

(1) Supervisory control for collision avoidance in vehicular networks using discrete event abstractions

Author: Eric Dallal, Alessandro Colombo, Domitilla Del Vecchio, Stéphane Lafortune

Abstract

We consider the problem of controlling a set of vehicles at an intersection, in the presence of uncontrolled vehicles and a bounded disturbance. We begin by discretizing the system in space and time to construct a suitable discrete event system (DES) abstraction, and formally define the problem to be solved as that of constructing a supervisor over the discrete state space that is safe (i.e., collision-free), non-deadlocking (i.e., the vehicles all cross the intersection eventually), and maximally permissive with respect to the chosen discretization. We show how to model the uncontrolled vehicles and the disturbance through uncontrollable events of the DES abstraction. We define two types of relations between systems and their abstraction: state reduction and exact state reduction. We prove that, when the abstraction is a state reduction of a continuous system, then we can obtain a safe, non-deadlocking, and maximally permissive memoryless supervisor. This is obtained by translating safety and non-deadlocking specifications to the abstract domain, synthesizing the supervisor in this domain, and finally translating the supervisor back to the concrete domain. We show that, when the abstraction is an exact state reduction, the resulting supervisor will be maximally permissive among the class of all supervisors, not merely memoryless ones. Finally, we provide a customized algorithm and demonstrate its scalability through simulation.

Full-text available at:
http://link.springer.com/article/10.1007/s10626-016-0228-3

(2) Computation of the delay bounds and synthesis of diagnosers for decentralized diagnosis with conditional decisions

Author: Shoichi Yokota, Takashi Yamamoto, Shigemasa Takai

Abstract

We consider decentralized diagnosis of discrete event systems in the conditional disjunctive and conjunctive architectures, where the local failure decision and local nonfailure decision are conditional, respectively. For each of these architectures, a notion of conditional codiagnosability, which guarantees the detection of any failure by conditional decentralized diagnosis within a bounded number of steps, has been defined in the literature. In this paper, we compute the minimum number of steps, called the delay bound, within which the occurrence of any failure can be detected in a conditionally codiagnosable system. The delay bound is important to evaluate the ability of diagnosis. In addition, we use the computed delay bound to synthesize local diagnosers with conditional decisions.

Full-text available at:
http://link.springer.com/article/10.1007/s10626-016-0229-2

(3) On the stability of a class of non-monotonic systems of parallel queues

Author: Pascal Moyal

Abstract

We investigate, under general stationary egrgodic assumptions, the stability of systems of S parallel queues in which any incoming customer joins the queue of the server having the p + 1-th shortest workload (p < S), or a free server if any. This change in the allocation policy makes the analysis much more challenging with respect to the classical FCFS model with S servers, as it leads to the non-monotonicity of the underlying stochastic recursion. We provide sufficient conditions for the existence of a stationary workload, which indicate a “splitting” of the system in heavy traffic, into a loss system of p servers (that is, a system with p servers and no waiting room), plus a FCFS system of S - p servers. To prove this result, we show en route an original sufficient condition for the existence and uniqueness of a stationary workload for a multiple-server loss system.

Full-text available at:
http://link.springer.com/article/10.1007/s10626-016-0230-9

(4) Maximally permissive controlled system synthesis for non-determinism and modal logic

Author: A.C. van Hulst, M.A. Reniers, W.J. Fokkink

Abstract

We propose a new technique for controlled system synthesis on non-deterministic automata for requirements in modal logic. Synthesis, as defined in this paper, restricts a behavioral specification of the uncontrolled system such that it satisfies a given logical expression, while adhering to the rules dictated by supervisory control such as maximal permissiveness and controllability. The applied requirement formalism extends Hennessy-Milner logic with the invariant and reachability modalities from Gödel-Löb logic, and is therefore able to express a broad range of control requirements, such as marker state reachability and deadlock-freeness. This paper contributes to the field of control synthesis by achieving maximal permissiveness in a non-deterministic context for control requirements in modal logic, and treatment of controllability via partial bisimulation. We present a well-defined and complete derivation of the synthesis result, which is supported further by computer-verified proofs created using the

Coq proof assistant. The synthesis method is also presented in algorithmic form, including an analysis of its computational complexity. We show that the proposed synthesis theory allows full expressibility of Ramadge-Wonham supervisory control theory and we illustrate its applicability in two small industrial case studies, including an analysis with regard to scalability.

Full-text available at:
http://link.springer.com/article/10.1007/s10626-016-0231-8

(5) Diagnosability analysis of patterns on bounded labeled prioritized Petri nets

Author: Houssam-Eddine Gougam, Yannick Pencolé, Audine Subias

Abstract

Checking the diagnosability of a discrete event system aims at determining whether a fault can always be identified with certainty after the observation of a bounded number of events. This paper investigates the problem of pattern diagnosability of systems modeled as bounded labeled prioritized Petri nets that extends the diagnosability problem on single fault events to more complex behaviors. An effective method to automatically analyze the diagnosability of a pattern is proposed. It relies on a specific Petri net product that turns the pattern diagnosability problem into a model-checking problem.
Full-text available at:
http://link.springer.com/article/10.1007/s10626-016-0234-5

(6) On a generalization of power algorithms over max-plus algebra

Author: Kistosil Fahim, Subiono, Jacob van der Woude

Abstract

In this paper we discuss a generalization of power algorithms over max-plus algebra. We are interested in finding such a generalization starting from various existing power algorithms. The resulting algorithm can be used to determine the so-called generalized eigenmode of any square regular matrix over max-plus algebra. In particular, the algorithm can be applied in the case of regular reducible matrices in which the existing power algorithms can not be used to compute eigenvalues and corresponding eigenvectors.

Full-text available at:
http://link.springer.com/article/10.1007/s10626-016-0235-4
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SELECTIONS OF THE IEEE TRANSACTIONS ON SYSTEMS, MAN AND CYBERNETICS: SYSTEMS
VOLUME: 47 ISSUE: 2
February 2017

(1) Compact Supervisory Control of Discrete Event Systems by Petri Nets With Data Inhibitor Arcs

Author: YuFeng Chen, ZhiWu Li, Kamel Barkaoui, NaiQi Wu, MengChu Zhou

Abstract

This work proposes a novel structure in Petri nets, namely data inhibitor arcs, and their application to the optimal supervisory control of Petri nets. A data inhibitor arc is an arc from a place to a transition labeled with a set of integers. A transition is disabled by a data inhibitor arc if the number of tokens in the place is in the set of integers labeled on it. Its formal definitions and properties are given. Then, we propose a method to design an optimal Petri net supervisor with data inhibitor arcs to prevent a system from reaching illegal markings with respect to control specifications. Two techniques are developed to reduce the supervisor structure by compressing the number of control places. Finally, a number of examples are used to illustrate the proposed approaches and experimental results show that they can obtain optimal Petri net supervisors for the net models that cannot be optimally controlled by pure net supervisors. A significant result is that the proposed approach can always lead to an optimal supervisor with only one control place for bounded Petri nets on the premise that such a supervisor exists.

Full-text available at: http://ieeexplore.ieee.org/document/7426418/
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