IEEE CONTROL SYSTEMS SOCIETY
TECHNICAL COMMITTEE ON DISCRETE EVENT SYSTEMS

Newsletter..... February 2019

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Contents:

1. Editorial

Welcome to the 2019 February issue of the newsletter,
also available electronically at
http://discrete-event-systems.ieeecss.org/tc-discrete/newsletters

You are welcome to submit new items to the newsletter (topics including schools, workshops, sessions, conferences, journals, books, software, positions).
To submit a new item, please email to kai.cai@eng.osaka-cu.ac.jp or use our mailing list at https://groups.google.com/a/nd.edu/forum/?hl=en#!forum/csstcdes-list

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2. Workshops and Invited Sessions

2.1. CfP: Invited Session or Workshop at 2019 Conference on Decision and Control (CDC'19)

Contributed by: Rong Su (rsu@ntu.edu.sg)

Dr. Rong Su and Dr. (Samuel) Qing-Shan Jia are planning to organize an invited session or a workshop on Resilient Discrete-Event Systems at CDC19, to be held in Nice, France, December 11-13. The concept of "resilience is in its broadest sense, e.g., fault tolerance, performance optimization, opacity, cyber attacks, and advanced modeling for real-time system analysis. This session/workshop will be co-sponsored by IEEE CSS TC on Discrete Event Systems and TC on Smart Cities.

If you are interested or have questions, please contact Dr. Rong Su (rsu@ntu.edu.sg).

2.2. CfP: Invited Session at 2019 Conference on Conference on Automation Science and Engineering (CASE'19)

Contributed by: Xiang Yin (yinxiang@sjtu.edu.cn)

Dr. Xiang Yin is planning to organize an invited session on Supervision and Estimation of Discrete-Event Systems at CASE19, to be held in Vancouver, BC, Canada, August 22-26. The objective of this special session is that of gathering recently developed novel approaches devoted to the estimation and supervision of automated

systems using DES models. This session/workshop will be sponsored by IEEE CSS TC on Discrete Event Systems.

If you are interested, please contact Dr. Xiang Yin (yinxiang@sjtu.edu.cn).

3. Selections of Journal Publications

Contributed by: Xiang Yin (yinxiang@sjtu.edu.cn)

3.1. SELECTIONS OF THE IEEE TRANSACTIONS ON AUTOMATIC CONTROL VOLUME: 64, ISSUE: 2, February 2019

(1) Model Checking in Isomorphic Module Systems

Authors: Weilin Wang ; Rong Su ; Liyong Lin ; Chaohui Gong

Abstract: With a growing number of interacting modules in today's complex systems, finding an effective tool for detecting design errors has become increasingly challenging. We present procedures for analyzing blocking or deadlock in systems consisting of isomorphic modules instantiated from a template. These procedures identify all possible blocking or deadlock sources and directly compute the maximum number of isomorphic modules under which the system is guaranteed to be nonblocking or deadlock-free.

Full-text available at: https://ieeexplore.ieee.org/document/8373702

(2) Optimizing Sensor Activation in a Language Domain for Fault Diagnosis

Authors: Weilin Wang ; Chaohui Gong ; Di Wang

Abstract: Sensors are activated/deactivated according to a sensor activation policy (SAP), which is a decision function whose domain is the language of the system. An SAP is minimal for diagnosability if it is at the point where the system is diagnosable, but any additional deactivation prevents correct system diagnosis. Given that the system is diagnosable when all sensors are always activated, we find in this paper that minimal SAP for diagnosability does not always exist. We therefore develop algorithms to compute a minimal SAP under which the system is pseudodiagnosable. Adhering to such a policy extends the window of opportunity for proper system diagnosis indefinitely, but with the compromise that later policy amendments are allowed.

Full-text available at: https://ieeexplore.ieee.org/document/8373703

(3) Formal Synthesis of Control Strategies for Positive Monotone

Systems

Authors: Sadra Sadraddini ; Calin Belta

Abstract: We design controllers from formal specifications for positive discrete-time monotone systems that are subject to bounded disturbances. Such systems are widely used to model the dynamics of transportation and biological networks. The specifications are described using signal temporal logic (STL), which can express a broad range of temporal properties. We formulate the problem as a mixed-integer linear program (MILP) and show that under the assumptions made in this paper, which are not restrictive for traffic applications, the existence of open-loop control policies is sufficient and almost necessary to ensure the satisfaction of STL formulas. We establish a relation between satisfaction of STL formulas in infinite time and set-invariance theories and provide an efficient method to compute robust control invariant sets in high dimensions. We also develop a robust model predictive framework to plan controls optimally while ensuring the satisfaction of the specification. Illustrative examples and a traffic management case study are included.

Full-text available at: https://ieeexplore.ieee.org/document/8310901

(4) Stability and Set Stability in Distribution of Probabilistic Boolean Networks

Authors: Yuqian Guo ; Rongpei Zhou ; Yuhu Wu ; Weihua Gui ; Chunhua Yang

Abstract: We propose a new concept, stability in distribution (SD) of a probabilistic Boolean network (PBN), which determines whether the probability distribution converges to the distribution of the target state (namely, a one-point distributed random variable). In a PBN, stability with probability one, stability in the stochastic sense, and SD are equivalent. The SD is easily generalized to subset stability, i.e., to set stability in distribution (SSD). We prove that the transition probability from any state to an invariant subset (or to a fixed point) is nondecreasing in time. This monotonicity is an important property in establishing stability criteria and in calculating or estimating the transient period. We also obtain a verifiable, necessary, and sufficient condition for SD of PBNs with independently and identically distributed switching. We then show that SD problems of PBNs with Markovian switching and PBN synchronizations can be recast as SSD problems of Markov chains. After calculating the largest invariant subset of a Markov chain in a given set by the newly proposed algorithm, we propose a necessary and sufficient condition for SSDs of Markov chains. The proposed method and results are supported by examples.

Full-text available at: https://ieeexplore.ieee.org/document/8354862

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3.2. SELECTIONS OF AUTOMATICA
VOLUME: 100, February 2019

(1) Optimal control of Boolean control networks with average cost: A policy iteration approach

Authors: Yuhu Wu ; Xi-Ming Sun ; Xudong Zhao ; Tielong Shen

Abstract: This paper deals with the infinite horizon optimal control problem for deterministic Boolean control networks (BCNs) with average cost. Based on the semi-tensor product of matrices and Jordan decomposition technique, a nested optimality equation for the average infinite horizon problem of BCNs is presented. By resorting to Laurent series expression, a novel policy iteration algorithm, which can find the optimal state feedback controller in finite iteration steps, is proposed. Finally, as a practical application, the optimal intervention problem of Ara operon in E. coil is addressed.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0005109818305703

(2) Distributed event-triggered control for global consensus of multi-agent systems with input saturation

Authors: Xinlei Yi ; Tao Yang ; Junfeng Wu ; Karl H. Johansson

Abstract: The global consensus problem for first-order continuous-time multi-agent systems with input saturation is considered. In order to reduce the overall need of communication and system updates, we propose an event-triggered consensus protocol and a triggering law, which do not require any a priori knowledge of global network parameters. It is shown that Zeno behavior is excluded for these systems and that the underlying directed graph having a directed spanning tree is a necessary and sufficient condition for global consensus. We use a new Lyapunov function to show the sufficient condition and it inspires the triggering law. Numerical simulations are provided to illustrate the effectiveness of the theoretical results.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0005109818305065

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3.3. SELECTIONS OF IEEE Transactions on Control Systems Technology
VOLUME: 27 ISSUE: 1, January 2019

(1) A Correction and Some Comments on the Article "Polynomially Complex Synthesis of Distributed Supervisors for Large-Scale AMSs Using Petri Nets"

Author: Spyros Reveliotis

Abstract: The main purpose of this correspondence is to point out the fallacy of Theorem 1 in the paper that is mentioned in the title, a result that attempts to provide a structural characterization for the liveness of the Petri net class considered in the manuscript. The closing part of the correspondence also takes this opportunity to make some further remarks on the results that are claimed in the paper.

Full-text available at: https://ieeexplore.ieee.org/document/7875490

(2) Diagnosability of Hybrid Systems

Authors: Oumar Diene ; Marcos V. Moreira ; Eduardo A. Silva ; Victor R. Alvarez ; Claudionor F. Nascimento

Abstract: Modern industrial systems combine discrete and continuous behaviors and thus are hybrid systems (HSs). In this brief, we introduce a new definition of diagnosability of HSs called h-diagnosability, and we present a method to verify this property. The method is based on a verifier automaton that can be constructed in polynomial time, leading to a smaller computational complexity for the verification of the diagnosability of HS than methods using diagnoser automata. The main idea is to build a verifier of the underlying discrete-event system, taking into account the distinguishability of the system modes based on the continuous state models of the HS.

Full-text available at: https://ieeexplore.ieee.org/document/8081784

(3) On Throughput Approximation of Resource-Allocation Systems by Bottleneck Regrowing

Authors: Ricardo J. Rodriguez ; Javier Campos

Abstract: Complex systems, such as manufacturing, logistics, or Web services, are commonly modeled as discrete event systems dealing with the resource-allocation problem. In particular, Petri nets (PNs) are a widely used formalism to model these systems. Although their functional properties have been extensively studied in the literature, their nonfunctional properties (such as throughput) have usually been ignored. In this brief, we focus on a PN subclass useful for modeling concurrent sequential processes with shared resources, termed S4PR nets. For these nets, we present an iterative strategy that makes intensive use of mathematical programming problems to approximate system throughput. Initially, our strategy selects the slowest part (a subsystem) of the net. Then, the next slowest parts are considered. In each step, the throughput is computed solving analytically the underlying continuous-time Markov chain when feasible (or by simulation, otherwise). Since only certain subsystems are considered, the state-explosion problem

inherent to the increasing net size is mitigated. We evaluate our strategy in a set of randomly generated S4PR nets. Our findings show that the throughput improves the upper throughput bound computation by almost 20% and that small portions of the net are enough to approximate system throughput.

Full-text available at: https://ieeexplore.ieee.org/document/8110834

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3.4. IEEE Transactions on Systems, Man, and Cybernetics: Systems
VOLUME: 49, ISSUE: 2, February 2019

(1) Fault Identification of Discrete Event Systems Modeled by Petri Nets With Unobservable Transitions

Authors: Guanghui Zhu ; Zhiwu Li ; Naiqi Wu ; Abdulrahman Al-Ahmari

Abstract: This paper deals with the identification problem of faulty behavior in a discrete event system, assuming that the fault-free model of a system is given in terms of Petri nets, where the set of transitions is divided into two disjoint subsets: 1) observable and 2) unobservable ones. The observed system output is defined as a transition-marking sequence, i.e., each transition is followed by a marking. First, a nonlinear integer programming model that characterizes the faults modeled by fault transitions is built according to the abnormal behavior extracted from the observed sequence. Then, it is converted into an integer linear programming (ILP) problem and a faulty net that preserves the structure of the fault-free one is obtained by solving this ILP model. In addition, an algorithm is developed to ensure acyclicity of the resulting unobservable subnet whose transition set is composed of the unobservable transitions of the fault-free net and the identified fault transitions.

Full-text available at: https://ieeexplore.ieee.org/document/8125566

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3.5. Nonlinear Analysis: Hybrid Systems
VOLUME: 31, February 2019

(1) Modeling and sensitivity analysis methodology for hybrid dynamical system

Authors: Sebastien Corner ; Corina Sandu ; Adrian Sandu

Abstract: This paper provides a complete mathematical framework to compute the sensitivities with respect to system parameters for any second order hybrid Ordinary Differential Equation (ODE) and ranked 1 and 3 Differential Algebraic Equation (DAE) system. The hybrid system is characterized by discontinuities in the velocity state variables due to an impulsive forces at the time of event. Such system may also exhibit at the time of event a change in the

equation of motions, or in the kinematic constraints. The methodology and the tools developed in this study compute the sensitivities of the states of the model and of the general cost functionals with respect to model parameters for both, unconstrained and constrained, hybrid mechanical systems. The analytical methodology that solves this problem is structured based on jumping conditions for both, the velocity state variables and the sensitivities matrix. The proposed analytical approach is then benchmarked against a known numerical method. Finally, this study emphasizes the penalty formulation for modeling constrained mechanical systems since this formalism has the advantage that it incorporates the kinematic constraints inside the equation of motion, thus easing the numerical integration, works well with redundant constraints, and avoids kinematic bifurcations.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S1751570X1830058X

(2) Periodic event-triggered dynamic output feedback control of switched systems

Authors: Guoqi Ma ; Prabhakar R.Pagilla

Abstract: This paper considers the problem of co-design of a dynamic output feedback controller and a periodic event-triggering mechanism for control of switched systems under limited communication resources. The dynamic output feedback controller is designed to utilize quantized output measurements which can reduce the load on communication; a logarithmic quantizer model is assumed. The event-triggering mechanism is designed to detect events periodically which can significantly reduce sampling frequency and preclude the occurrence of Zeno behavior due to continuous-time sampling. The governing equations of the physical system combined with the equations of the dynamic output feedback controller and the event-triggering mechanism are formulated as a switched delay system. For the closed-loop switched delay system, sufficient conditions in terms of Linear Matrix Inequalities (LMIs) are obtained to achieve exponential stability with a prescribed attenuation performance with respect to an exogenous disturbance; both weighted and non-weighted performance can be achieved with the proposed approach. Tools and techniques from delay-dependent Lyapunov theory, free-weighting matrices, Singular Value Decomposition (SVD), and average dwell time for switched systems are used to obtain the main results. A synthesis procedure is provided for obtaining the dynamic output feedback controller gains, event-triggering condition parameters, and a lower bound on the average dwell time of the switching signal. Numerical simulation results on a switched boost converter circuit system are provided to evaluate the proposed design and results.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S1751570X18300827

(3) Event-triggered feedback stabilization of switched linear systems using dynamic quantized input

Authors: Can Li ; Jie Lian

Abstract: This paper is concerned with the co-design of event-triggered sampling, dynamic input quantization and constrained switching for a switched linear system. The mismatch between the plant and its corresponding controller is considered. This behavior is raised by switching within the event-triggered sampling interval. Accordingly, novel update laws of dynamic quantization parameter are designed separately for matched sampling intervals (without switching) and mismatched sampling intervals (with a switch). We technically transform the total variation (increment or decrement) of Lyapunov functions in one sampling interval into the discrete-time update of quantization parameter. Based on this transformation, a hybrid quantized control policy is developed. This policy, in conjunction with the average dwell-time switching law and the constructed event-triggered condition, can ensure the exponential stabilization of the switched system with finite-level quantized input. Besides, the event-triggered scheme is proved to be Zeno-free. The effectiveness of the developed method is verified by a simulation example.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S1751570X18300840

4. Conferences

Contributed by: Xiang Yin (yinxiang@sjtu.edu.cn)

4.1 2019 European Control Conference
Naples, Italy, Jun 25 - Jun 28, 2019
https://ecc19.eu/

4.2 27th Mediterranean Conference on Control and Automation
Akko, Israel, Jul 1 - Jul 4, 2019
https://med19.net.technion.ac.il/

4.3 2019 American Control Conference
Philadelphia, Pennsylvania, United States, Jul 10 - Jul 12, 2019
http://acc2019.a2c2.org/

4.4 38th Chinese Control Conference (CCC 2019)
Guangzhou, China, Jul 27 - Jul 30, 2019
http://www.ccc2019.cn/en/index.html

4.5 2019 Conference on Control Technology and Applications
Hong Kong, China, Aug 19 - Aug 21, 2019
http://ccta2019.ieeecss.org/

4.6 15th International Conference on Automation Science and Engineering
Vancouver, British Columbia, Canada, Aug 22 - Aug 26, 2019
http://case2019.hust.edu.cn/index.htm

4.7 2019 Conference on Decision and Control
Nice, France, December 11-13, 2019
https://cdc2019.ieeecss.org/

5. Positions

5.1. Postdoc: Czech Academy of Sciences, Czech Republic
Contributed by: Jan Komenda (komenda@ipm.cz, komenda@math.cas.cz)

A postdoc position is available in Institute of Mathematics, Czech Academy of Sciences (Brno, Czech Republic) on Control of Concurrent Timed Discrete-Event Systems.

Position Description: A three year postdoc position is available for a candidate with background in discrete-event systems or similar area, and interest in modeling, analysis, and control of timed discrete-event systems. The successful candidate must hold a Ph.D. in a relevant area of engineering, computer science or applied mathematics, and will join a cooperation project (2019-2021) between Czech Academy of Sciences and German Universities TU Berlin and FAU Erlangen that aims at developing novel and scalable methods for supervisory control of concurrent timed discrete-event systems.

Applications including a detailed CV should be emailed to Dr. Jan Komenda (komenda@ipm.cz or komenda@math.cas.cz). If you need more details about the position please do not hesitate to contact Dr. Jan Komenda (komenda@ipm.cz, komenda@math.cas.cz).

5.2 Postdoc: Queen's University, Canada
Contributed by: Karen Rudie (karen.rudie@queensu.ca)

Postdoctoral Fellowship Competition: Dr. Karen Rudie is seeking a candidate whose application can be put forth for a postdoctoral research opportunity. This is a competition at Queen’s University and the successful candidate would receive funding for one year but with the expectation that they would aid in grant writing that would ideally lead to further funding for subsequent years.

Job Description: postdoctoral research in discrete-event systems with an emphasis on opacity and cyber-resilience problems.

Required skills:
- strong problem-solving skills
- a background in Control of Discrete-Event Systems (or

something close enough that you could easily hit the ground running)
· good people skills and good communication skills
· an eagerness to write up our work into publications
· leadership skills and able to train more junior researchers (i.e., graduate students or undergraduate summer researchers).