IEEE Control Systems Society
Technical Committee on Discrete Event Systems

Newsletter **June 2022**

Editor: Kai Cai
Chair, IEEE CSS Technical Committee on DES
Professor
Department of Core Informatics, Osaka Metropolitan University
3-3-138 Sugimoto, Sumiyoshi-ku, Osaka 558-8585, Japan

Phone: (+81) 6-6605-2703
Email: cai@omu.ac.jp
Website: https://www.control.eng.osaka-cu.ac.jp

Welcome to the 2022 June issue of the newsletter, also available online at
http://ieeecss.org/tc/discrete-event-systems/newsletters

Editorial

You are welcome to submit new items to the newsletter (topics including schools, workshops, sessions, conferences, journals, books, software, positions). Also please encourage relevant colleagues and students to subscribe to this newsletter.

- To **submit a new item**, please use the following website:
  https://www.control.eng.osaka-cu.ac.jp/miscellaneous/css-tc-des/submission
  or email to cai@eomu.ac.jp.
- To **subscribe**, please email to cai@omu.ac.jp.
- To **unsubscribe**, please reply to this email with the subject line UNSUBSCRIBE.

Contents

1 Selections of Journal Publications

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

1.1. Discrete Event Dynamic Systems: Theory and Applications

Volume 32, Issue 2, June 2022

- **Decentralized diagnosis of discrete event systems subject to permanent sensor failures**
  Authors: Akihito Wada ; Shigemasa Takai
  Abstract: In this paper, we consider a decentralized failure diagnosis problem for discrete event systems. Each local diagnoser makes a diagnosis decision based on local event observations. A sensor that detects the occurrence of an event may possibly fail due to, for example, aging degradation. It is desirable that the occurrence of any failure string should be correctly detected in the presence of sensor failures. We introduce a new notion of codiagnosability subject to permanent sensor failures, which is defined with respect to not only the set of nondeterministic local observation masks but also the global nondeterministic observation mask. Although the global observation mask is necessary to define codiagnosability, it is not used for performing decentralized diagnosis. The introduced notion of codiagnosability guarantees that the occurrence of any failure string can be correctly detected by a decentralized diagnoser within a bounded number of steps even if permanent sensor failures occur. We develop a method for verifying the codiagnosability property subject to permanent sensor failures. In addition, we compute the delay bound within which the occurrence of any failure string can be detected.
- **Parallel decomposition and concurrent satisfaction for heterogeneous multi-robot task and motion planning under temporal logic specifications**
  Authors: Huanfei Zheng ; Yue Wang
  Abstract: This paper presents an automaton-based task and motion planning framework for multi-robot systems (MRS) to satisfy finite words of linear temporal logic (LTL) task specifications in parallel and concurrently. A parallel decomposition algorithm is developed to iteratively decompose a global task specification into a set of smaller subtask automata. Robots are assigned to the smallest task component in each subtask automaton. The capability transition system of the assigned robots and these subtask automata synthesize a corresponding set of subtask planning automata (SPA), each of which is either an independent satisfaction of an individual subtask automaton or a concurrent satisfaction of multiple subtask automata. The overall robot assignments and SPA can guarantee the MRS to satisfy all the subtask automata. Each SPA can generate a minimal cost task plan by taking into account the costs of multi-robot tasking. The robots then plan motions to execute the tasks associated with the minimal cost task plans. The proposed framework is demonstrated with a multi-robot experiment for manufacturing tasks in a lab setting. Extensive numerical simulations are also performed to evaluate the scalability, computational complexity, and execution efficiency of the proposed framework and show its advantages over the centralized task and motion planning strategy.
- **Local and global robustness with q-step delay for max-plus linear systems**
  Authors: Yingxuan Yin ; Yuegang Tao ; Cailu Wang ; Haiyong Chen
  Abstract: This paper studies the local and global robustness with q-step delay of max-plus linear systems, which requires part or all components of the state vectors remain unchanged under the bounded parameter perturbations after a finite number of steps. A graph approach based on the circuit with tail is proposed to determine the variable elements with respect to the local and global robustness. This approach induces a polynomial algorithm of finding the variable elements and their perturbation bounds, which is illustrated by numerical examples and simulations. The approach proposed is then applied in making train running-plan of railway transport systems, which allows the trains to have flexible traveling times.
- **A general language-based framework for specifying and verifying notions of opacity**
  Authors: Andrew Wintenberg ; Matthew Blischke ; Stephane Lafortune ; Necmiye Ozay
  Abstract: Opacity is an information flow property that captures the notion of plausible deniability in dynamic systems, that is whether an intruder can deduce that âĂIJsecretâĂİ behavior has

occurred. In this paper we provide a general framework of opacity to unify the many existing notions of opacity that exist for discrete event systems. We use this framework to discuss language-based and state-based notions of opacity over automata. We present several methods for language-based opacity verification, and a general approach to transform state-based notions into language-based ones. We demonstrate this approach for current-state and initial-state opacity, unifying existing results. We then investigate the notions of K-step opacity. We provide a language-based view of K-step opacity encompassing two existing notions and two new ones. We then analyze the corresponding language-based verification methods both formally and with numerical examples. In each case, the proposed methods offer significant reductions in runtime and space complexity.

- **Discovering Petri nets including silent transitions. A repairing approach based on structural patterns**
  Authors: Roman Pomares-Angelino ; Ernesto Lopez-Mellado
  Abstract: The paper presents a novel approach for discovering Petri nets (PN) that include silent transitions from logs of event sequences. We propose a repairing method that extends existing discovery techniques that do not deal with silent transitions; such techniques may yield substructures that involve deadlocks. Such substructures, called inconsistent (IS), are detected through a structural pattern. IS are rewritten by adding new transitions labelled with event symbols already assigned to transitions in IS; the rewritten model has no deadlocks. Afterwards, the PN with duplicated event labels is transformed into an equivalent model with silent transitions. The algorithms derived from the technique, which have polynomial-time complexity, have been implemented and tested on examples of diverse structures.

- **Transformational supervisor synthesis for evolving systems**
  Authors: Sander Thuijsman ; Michel Reniers
  Abstract: Supervisory controller synthesis is a means to compute correct-by-construction controllers for discrete event systems. As these systems and their requirements evolve over time, an updated supervisor needs to be computed each time an adaptation takes place. We consider the case that a supervisor has been synthesized for a given model, after which this model is (slightly) adapted. We investigate how we can make use of the previous synthesis result, in order to more efficiently compute the supervisor for the adapted model. We introduce model deltas as a means to describe the difference between pairs of models. Using the model deltas, a notion of atomic adaptations is introduced. For these atomic adaptations, algorithms are provided to compute the supervisor for the adapted model in a transformational manner from the previous synthesis result, rather than performing a completely new synthesis. These atomic adaptations can be iterated over, to transformationally compute a supervisor for model deltas that contain a number of atomic adaptations. To improve efficiency, it is shown how atomic adaptations can be grouped together based on their required computations and be processed at the same time. A running example is used to support the explanations on the functioning of the algorithms. The efficiency of the method is evaluated by means of both an academic and an industrial use case.

Back to the contents

1.2. IEEE Transactions on Automatic Control

Volume: 67, Issue: 6, June 2022

- **Synthesis of Optimal Multiobjective Attack Strategies for Controlled Systems Modeled by Probabilistic Automata**
  Authors: Romulo Meira-Goes ; Raymond H. Kwong ; Stephane Lafortune
  Abstract: In this article, we study the security of control systems in the context of the supervisory control layer of stochastic discrete-event systems. Control systems heavily rely on correct communication between the plant and the controller. In this article, we consider that such communication is partially compromised by a malicious attacker. The attacker has the ability to modify a subset of the sensor readings and mislead the supervisor, with the goal of inducing the system into an unsafe state. We consider this problem from the attacker's viewpoint and investigate the synthesis of an attack strategy for systems modeled as probabilistic automata. Specifically, we investigate the synthesis of attack functions constrained by multiple objectives. We proceed in two steps. First, we

quantify each attack strategy based on the likelihood of successfully reaching an unsafe state. Based on this quantification, we study the problem of synthesizing attack functions with the maximum likelihood of successfully reaching an unsafe state. Second, we consider the problem of synthesizing attack functions that have the maximum likelihood of successfully reaching an unsafe state while minimizing a cost function, i.e., the synthesis of attack functions is constrained by multiple objectives. Our solution methodology is based on mapping these problems to optimal control problems for Markov decision processes, specifically, a probabilistic reachability problem and a stochastic shortest path problem.

- **Optimal Secret Protections in Discrete-Event Systems**
  Authors: Ziyue Ma ; Kai Cai
  Abstract: In this article, we study a security problem of protecting secrets in discrete-event systems modeled by deterministic finite automata. In the system, some states are defined as secrets, each of which is associated with a security level. The problem is to design an event-protecting policy such that any event sequence from the initial state that reaches a secret state contains a number of protected events no less than the required level of security. To solve this secret securing problem, we first develop a layered structure called the security automaton. Then, we show that the problem is transformed to a supervisory control problem in the security automaton. We consider two criteria of optimality on protecting policies: 1) disruptiveness, i.e., protecting policies with a minimum degree of disturbance to legal users' normal operations; and 2) cost, i.e., protecting policies with a minimal cost. For the optimality on disruptiveness, we prove that a minimally disruptive protecting policy is obtained by using the classical supervisory control theory in the security automaton. For the optimality on cost, we develop a method to obtain a protecting policy with minimal cost by finding a min-cut in the security automaton.

- **Supervisory Control of Timed Discrete-Event Systems With Logical and Temporal Specifications**
  Authors: Francesco Basile ; Roberto Cordone ; Luigi Piroddi
  Abstract: A novel framework is introduced for the supervisory control (SC) of timed discrete event systems based on Time Petri nets. The method encompasses both logical (markings to reach or avoid) and temporal specifications (arrival and departure times in specific markings). It relies on the construction of a partial forward reachability graph of the modified state class graph type and the formulation of integer linear programming problems to establish suitable firing time intervals (FTIs) for the controllable transitions. For each enabled controllable transition, the SC algorithm provides the largest FTI that that the specifications are met, irrespectively of the firing times of the uncontrollable transitions.

- **SMT-Based Reachability Analysis of High Dimensional Interval Max-Plus Linear Systems**
  Authors: Muhammad Syifaul Mufid ; Dieky Adzkiya ; Alessandro Abate
  Abstract: This article discusses the reachability analysis (RA) of interval max-plus linear (IMPL) systems, a subclass of continuous-space, discrete-event systems defined over the max-plus algebra. Unlike standard max-plus linear systems, where the transition matrix is fixed at each discrete step, IMPL systems allow for uncertainty on state matrices. Given an initial and a target set, we develop algorithms to verify the existence of IMPL system trajectories that, starting from the initial set, eventually reach the target set. We show that RA can be solved by encoding the IMPL system, as well as initial and target sets, into linear real arithmetic expressions, and then checking the satisfaction of a resulting logical formula via a satisfiability modulo theory (SMT) solver. The performance and scalability of the developed SMT-based algorithms are shown to drastically outperform state-of-the-art RA algorithms applied to IMPL systems, which promises to usher their use in practical, industrial-sized IMPL models.

Back to the contents

1.3. Automatica

Volume: 140, June 2022

- **A framework for current-state opacity under dynamic information release mechanism**
  Authors: Junyao Hou ; Xiang Yin ; Shaoyuan Li
  Abstract: Opacity is an important information-flow security property that characterizes the plausible deniability of a dynamic system for its "secret" against eavesdropping attacks. As an information-flow property, the underlying observation model is the key in the modeling and analysis of opacity. In this paper, we investigate the verification of current-state opacity for discrete-event systems under Orwellian-type observations, i.e., the system is allowed to re-interpret the observation of an event based on its future suffix. First, we propose a new Orwellian-type observation model called the dynamic information release mechanism (DIRM). In the DIRM, when to release previous "hold on" events is state-dependent. Then we propose a new definition of opacity based on the notion of history-equivalence rather than the standard projection-equivalence. This definition is more suitable for observations that are not prefix-closed. Finally, we show that by constructing a new structure called the DIRM-observer, current-state opacity can be effectively verified under the DIRM. Computational complexity analysis as well as illustrative examples for the proposed approach is also provided. Compared with the existing Orwellian-type observation model, the proposed framework is more general in the sense that the information-release-mechanism is state-dependent, information is partially released and the corresponding definition of opacity is more suitable for non-prefix-closed observations.
- **Verification of K-step and infinite-step opacity of bounded labeled Petri nets**
  Authors: Yin Tong ; Hao Lan ; Carla Seatzu
  Abstract: Opacity is an important information security property. Given a discrete event system, a set of secret states, and an intruder who observes the system evolution through an observation mask, the system is said to be K-step opaque if the intruder is not able to ascertain that the system is or was in a secret state at some time within K steps, namely within the observation of K events. If the intruder is never able to ascertain that the system is or was in a secret state at any time, the system is said to be infinite-step opaque. This work aims at verifying the two opacity properties when the discrete event system is modeled as a bounded labeled Petri net. Using the notion of basis reachability graph, new approaches are proposed to check K-step opacity and infinite-step opacity. The proposed approaches are shown to be more efficient than the standard methods based on the reachability graph.
- **K-loss robust codiagnosability of Discrete-Event Systems**
  Authors: Vinicius de Souza Lima Oliveira ; Felipe Gomes Cabral ; Marcos Vicente Moreir
  Abstract: Recently, the problem of robust diagnosis against loss of event observations has been proposed in the literature, where it is assumed that some sensors, or communication channels between sensors and diagnosers, are subject to failures. In these works, permanent or intermittent failures are considered, and models of the plant subject to these failures are obtained. One characteristic of the robust diagnosis method considering intermittent failures is that the faulty sensor may or may not recover from the failure, and the intermittent failures may evolve to permanent failures, which are also represented in the model of the plant subject to intermittent failures. However, in some cases, i.e., the communication failure is transient due to external interference, , the communication channel always recovers from the failure after a short period of time. In this paper, we formulate the problem of robust diagnosis against transient sensor communication failures. The new formulation leads to the definition of K-loss robust codiagnosability. We also present a method to verify this property.
- **Enforcement for infinite-step opacity and K-step opacity via insertion mechanism**
  Authors: Rongjian Liu ; Jianquan Lu
  Abstract: Opacity is an important information-flow property concerning the security and privacy of cyber-physical systems. We investigate the synthesis problem of infinite-step opacity and K-step opacity by using insertion function. An insertion function is a monitoring interface placed between the system and the outside observer that inserts fictitious events to the system output if necessary. To successfully enforce infinite-step opacity and K-step opacity, in this paper, we first

review the insertion mechanism without considering the opacity enforcement issue, and propose two new automata for recognizing the safe languages for infinite-step opacity and K-step opacity respectively. Then, we enforce the infinite-step opacity and the K-step opacity with the reviewed insertion mechanism. Computational complexity issues are also discussed. Our results extend the prior results about the synthesis of insertion functions from the notion of current-state opacity to the notions of infinite-step opacity and K-step opacity.

- **Characterization, verification and generation of strategies in games with resource constraints**
  Authors: Chanjuan Liu ; Enqiang Zhu ; Yuanke Zhang ; Qiang Zhang ; Xiaopeng Wei
  Abstract: With an increasing demand for ensuring the reliability and efficiency of distributed and interactive systems, the model-checking technique has been studied extensively, for which a game-based modeling of the system and a logical specification of the desired properties are two essential parts. Existing studies mainly focused on ideal systems that always guarantee optimal responses and have not considered several realistic aspects, for instance, the fact that actions can only be performed under sufficient resources. In this paper, we propose a game model with resource constraints and thereby a novel logic named LRC for such games. This logic enables the strategic reasoning of the likely strategies of the other participating entities and thus supports not only the characterization of the equilibrium of games with limited resources, but also strategic exploitation in multi-agent systems in which the available resources are restricted. Interesting properties of this logic are investigated, and a model-checking algorithm is presented. Being built upon the alternating-time temporal logic (ATL), LRC is shown to be more expressive than ATL without bringing additional complexity. In addition to determining the existence or absence of a collaborative strategy, we explore the generation of the team plan when a certain protocol is supposed to be followed.

- **Decentralized route-planning for multi-vehicle teams to satisfy a subclass of linear temporal logic specifications**
  Authors: Jie Fang ; Zetian Zhang ; Raghvendra V.Cowlagi
  Abstract: Linear temporal logic (LTL) formulae are widely used to provide high level behavioral specifications on mobile robots. We propose a decentralized route-planning method for a networked team of mobile robots to satisfy a common (global) LTL specification. The global specification is assumed to be a conjunction of multiple formulae, each of which is treated as a task to be assigned to one or more vehicles. The vehicle kinematic model consists of two modes: a hover mode and a constant-speed forward motion mode with bounded steering rate. The proposed method leverages the consensus-based bundle algorithm for decentralized task assignment, thereby decomposing the global specification into local specifications for each vehicle. We develop a new algorithm to assign collaborative tasks: those simultaneously assigned to multiple vehicles. Rewards in the proposed task assignment algorithm are computed using the so-called lifted graph, which ensures the satisfaction of minimum turn radius constraints on vehicular motion. This algorithm synchronizes the vehicles' routes with minimum waiting durations. The proposed method is compared against a multi-vehicle task assignment algorithm from the literature, which we extend to apply for satisfying LTL specifications. The proposed route-planning method is demonstrated via numerical simulation examples and a hardware implementation on networked single-board computers.

Back to the contents

1.4. IEEE Control Systems Letter

Volume: 6, Issue: 5, June 2022

- **Necessary and Sufficient Condition to Assess Initial-State-Opacity in Live Bounded and Reversible Discrete Event Systems**
  Authors: Francesco Basile ; Gianmaria De Tommasi ; Carlo Motta ; Claudio Sterle
  Abstract: Opacity is a property of discrete event systems (DES) that is related to the possibility of hiding a secret from external observers (the intruders). When the secret is the initial state of the system, the related opacity problem is referred to as Initial State Opacity (ISO). A necessary and sufficient condition to check ISO in DES modeled as Petri nets (PN) is given in this letter. By exploiting both the structural properties of PNs and the algebraic description of their dynamic, we

propose to assess ISO by solving Integer Linear Programming problems.

- **Safe Learning for Uncertainty-Aware Planning via Interval MDP Abstraction**
  Authors: Jesse Jiang ; Ye Zhao ; Samuel Coogan
  Abstract: We study the problem of refining satisfiability bounds for partially-known stochastic systems against planning specifications defined using syntactically co-safe Linear Temporal Logic (scLTL). We propose an abstraction-based approach that iteratively generates high-confidence Interval Markov Decision Process (IMDP) abstractions of the system from high-confidence bounds on the unknown component of the dynamics obtained via Gaussian process regression. In particular, we develop a synthesis strategy to sample the unknown dynamics by finding paths which avoid specification-violating states using a product IMDP. We further provide a heuristic to choose among various candidate paths to maximize the information gain. Finally, we propose an iterative algorithm to synthesize a satisfying control policy for the product IMDP system. We demonstrate our work with a case study on mobile robot navigation.

Back to the contents

1.5. Control Engineering Practice

Volume: 123, June 2022

- **An effective approach for fault diagnosis of Discrete-Event Systems modeled as safe labeled Petri nets**
  Authors: Ana C.Bonafin ; Felipe G.Cabral ; Marcos V.Moreira
  Abstract: In this paper, a fault diagnosis method for Discrete-Event Systems (DES) modeled as safe labeled Petri nets (LPN) is proposed. We assume that some transitions of the Petri net are unobservable, including the fault transitions. The diagnosis method consists of two steps: (i) in the first step, online fault detection is carried out; and (ii) then, by using the observed sequence of events and the labeled Petri net system model, the fault candidates are isolated. The online fault detection is based on the construction of an LPN from the fault-free system behavior model, called observable behavior Petri net (OBPN), whose transitions are all observable, and whose generated language is guaranteed to be equal to the observable language of the fault-free system model when some conditions are satisfied. It is also shown that the OBPN can be implemented for fault detection instead of implementing the reachability graph, or even part of it, which leads to a fast fault detection method without requiring the use of a large amount of memory. Two case studies are presented to illustrate the proposed method.

- **Security-preserving multi-agent coordination for complex temporal logic tasks**
  Authors: Xinyi Yu ; Xiang Yin ; Shaoyuan Li ; Zhaojian Li
  Abstract: This paper investigates the coordination of multiple agents for high-level tasks described by linear temporal logics (LTL). The general purpose for multi-agent coordination is to synthesize a plan such that the LTL task is achieved optimally. In addition to the standard requirement on the correctness of the plan, we further investigate the potential information leakage of each agent during the operating process. Specifically, we consider the scenario where the behavior of each individual agent is partially monitored by a passive intruder modeled as an outside observer or an eavesdropper. The security constraint requires that the intruder can never identify for sure that some specific individual agent is carrying out some sub-tasks of significant importance. To this end, we model the mobile capability of the agent team by a global labeled transition system. To describe information-flow security constraint, motivated by the generic notion of opacity, two different types security requirements are proposed for each individual agent. An effective coordination algorithm is proposed that synthesizes an optimal global plan for the entire agent team such that the global LTL task can be achieved, while the security of each individual agent is preserved. The proposed framework is implemented in real-world experiment and is also demonstrated by several case studies.

Back to the contents

1.6. IEEE Transactions on Systems, Man, and Cybernetics: Systems

Volume: 52, Issue: 5, June 2022

- **Adaptive Deadlock Control for a Class of Petri Nets With Unreliable Resources**
  Authors: Ziliang Zhang ; Gaiyun Liu ; Kamel Barkaoui ; Zhiwu Li
  Abstract: In an automated manufacturing system (AMS), resources are, in general, subject to unpredictable failures, which invalidate many existing deadlock control strategies. In this article, we propose an adaptive deadlock control policy for an AMS with multiple types of unreliable resources. The considered AMS is modeled with a system of simple sequential processes with resources. First, based on an elementary siphon control method, monitors are added for elementary siphons and some particular dependent siphons to ensure the liveness of a system if there are no resource failures. By considering the fact that an unreliable resource may fail in a system, recovery subnets are added to describe the resource failures and recoveries. Since a monitor added for a siphon may not be able to guarantee that the corresponding siphon is always marked if the failure of a resource in the siphon occurs, the concept of switch controllers is presented so as to make the siphon always remarked if it is emptied by resource failures. It is verified that the adaptive controller proposed in this article can guarantee the liveness of the controlled system no matter whether unreliable resources break down or not. More importantly, if there is no resource failure, the system can maintain predefined production without degrading planned system performance. Finally, examples are presented to illustrate the validity of the proposed method.
- **Critical Observability of Discrete-Event Systems in a Petri Net Framework**
  Authors: Xuya Cong ; Maria Pia Fanti ; Agostino Marcello Mangini ; Zhiwu Li
  Abstract: This article focuses on the issue of checking critical observability for labeled Petri nets. Critical observability is a property related to the safety concern of cyber-physical systems. With the aim of checking this property of a net system, it is required to detect whether a set of markings consistent with any observed word of the net system is a subset of a set of critical states representing undesirable operations or a set of noncritical states. In this work, we prove a necessary and sufficient condition to check critical observability when the critical state set is described by an arbitrary subset of reachable markings. Then, the result is extended to the case when a critical state set is modeled by all the reachable markings that satisfy disjunctions of generalized mutual exclusion constraints. The proposed method is derived from the solutions of integer linear programming problems and is applicable to net systems with liveness and boundness. Several case studies show the performance of the presented methodology for discrete-event systems.

Back to the contents

1.7. Nonlinear Analysis: Hybrid Systems

Volume: 44, May 2022

- **Robust decentralized diagnosability of networked discrete event systems against DoS and deception attacks**
  Authors: Marcos V.S. Alves ; Raphael J. Barcelos ; Lilian K. Carvalho ; Joao C. Basilio
  Abstract: Denial-of-Service (DoS) are attacks conducted by malicious agents that consists in disrupting, temporally or indefinitely, the services provided by a communication network. When a malicious agent gets access to some network node, it may also perform deception attacks by inserting valid packets with fake information into vulnerable channels. We address, in this paper, DoS and deception attacks (DoS-D attack) that flood some communication channels with fake packets causing delays, loss of observations and insertion of fake observations, and their implications in decentralized fault diagnosability of networked discrete event systems (NDES). To this end, we propose an automaton model for NDES subject to DoS-D attacks that represents the adverse effects of DoS-D attacks on the observations of local diagnosers. We introduce a new codiagnosability definition called DoS-D-robust codiagnosability, and present a necessary and sufficient condition for a language to be DoS-D-robustly codiagnosable. We also propose a verification algorithm for regular languages to check DoS-D-robust codiagnosability.

Back to the contents

2 Conferences

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

2.1 **2022 American Control Conference (ACC)**
Atlanta, Georgia, USA, June 8-10, 2022
https://acc2022.a2c2.org/

2.2 **2022 IEEE Conference on Control Technology and Applications (CCTA)**
Stazione Marittima, Trieste, Italy, August 23-25, 2022
https://acc2022.a2c2.org/

2.3 **2022 IEEE International Conference on Automation Science and Engineering (CASE)**
Mexico City, Mexico, August 20-24, 2022
http://www.case2022.org/

2.4 **2022 International Workshop on Discrete Event Systems (WODES)**
Prague, Czechia, September 7-9, 2022
https://wodes2022.math.cas.cz

2.5 **2022 IEEE International Conference on Systems, Man, and Cybernetics (SMC)**
Prague, Czech Republic, October 9-12, 2022
https://ieeesmc2022.org/

2.6 **2022 IEEE Conference on Decision and Control (CDC)**
Cancun, Mexico, December 6-9, 2022
https://cdc2022.ieeecss.org/

Back to the contents

3 Books

3.1 Analysis and Control for Resilience of Discrete Event Systems

Authors: Joao Carlos Basilio, Christoforos N. Hadjicostis and Rong Su

Description: System resilience captures the ability of the system to withstand a major disruption within acceptable performance degradation and to recover within an acceptable time frame. In this monograph we consider two possible sources of major disruptions, i.e., component faults and cyber intrusions. A component fault is an indigenous activity that renders unavailability or inaccessibility of certain functions within a component, either permanently or temporarily. It typically generates safety and performance concerns. Cyber intrusion on the other hand is an exogenous activity that tampers privacy, confidentiality, availability, or integrity of the system. These two sources are not always independent from each other. For example, a cyber intrusion may trigger a component fault, whereas a component fault may open a door for cyber intrusion, e.g., by keeping it undetected. For cyber intrusion, we will focus on opacity, which describes the system's ability to hide certain secrets from an external observer (or eavesdropper), and sensor and actuator attacks that exploit the system's existing controller to generate undesirable behaviours.

In this monograph, we provide a detailed account of most recent research outcomes on fault diagnosis, opacity analysis and enhancement, and cyber security analysis and enforcement, within suitable discrete event system modelling frameworks. In each case, we describe basic problem statements and key concepts, and then point out the key challenges in each research area. After that, we present a thorough review of state-of-the-art techniques, and discuss their advantages and disadvantages. Finally, we highlight key research directions for further exploration.

ISBN: 978-1-68083-856-5
https://www.nowpublishers.com/article/Details/SYS-024

3.2 Introduction to Discrete Event Systems

Authors: Christos Cassandras and Stephane Lafortune

Description: Christos Cassandras and Stephane Lafortune are happy to announce the publication of the third edition of their textbook, Introduction to Discrete Event Systems, by Springer in November 2021. The first two editions of this popular textbook were published in 1999 (Kluwer Academic Publishers) and 2008 (Springer), respectively. This unique textbook comprehensively introduces the field of discrete event systems, offering a breadth of coverage that makes the material accessible to readers of varied backgrounds. The book emphasizes a unified modeling framework that transcends specific application areas, linking the following topics in a coherent manner: language and automata theory, supervisory control, Petri net theory, Markov chains and queueing theory, discrete-event simulation, and perturbation analysis and concurrent estimation techniques. The third edition is a "superset" of the second one, with new material added based on our teaching of discrete event systems courses at Boston University and at the University of Michigan, and they reflect active research trends in discrete event systems since the publication of the second edition.

Topics and features:
- detailed treatment of automata and language theory in the context of discrete event systems, including application to state estimation and diagnosis
- comprehensive coverage of centralized and decentralized supervisory control
- timed models, including timed automata and hybrid automata - stochastic models for discrete event systems and controlled Markov chains
- discrete event simulation - an introduction to stochastic hybrid systems
- sensitivity analysis and optimization of discrete event and hybrid systems
- new in the third edition: opacity properties, enhanced coverage of event diagnosis and of supervisory control under partial observation, overview of latest software tools, updated treatment of Infinitesimal Perturbation Analysis and of concurrent estimation

This proven textbook is essential to students and researchers in a variety of disciplines where the study of discrete event systems is relevant: control, communications, computer engineering, computer science, manufacturing engineering, transportation networks, operations research, and industrial engineering. This book is available through SpringerLink as an e-book (PDF and EPUB formats) or as a print-on-demand hard cover at https://link.springer.com/book/10.1007/978-3-030-72274-6 The e-book is available for free download at Springer subscribing institutions.

ISBN 978-3-030-72272-2 ISBN 978-3-030-72274-6 (eBook)
https://doi.org/10.1007/978-3-030-72274-6

3.3 Hybrid Dynamical Systems – Fundamentals and Methods

Authors: Hai Lin and Panos Antsaklis

Description: This book is based on courses on hybrid systems, cyber-physical systems, and formal methods taught by the authors in the past years. It is a graduate level textbook and provides an accessible and comprehensive introduction to the theory of hybrid systems with a balanced treatment on fundamentals and methods from both control theory and computer science. It also serves as a reference book for researchers in the fields of hybrid dynamical systems, cyber-physical systems, formal methods and robotics.

More information may be found at the bookâĂŹs Springer webpage:

https://link.springer.com/book/10.1007/978-3-030-78731-8

Back to the contents

4 Software Tools

4.1 MDESops

MDESops is an open-source tool written in Python for analysis and control of discrete event systems modeled as finite-state automata. It includes a growing set of operations on automata, including: (i) manipulation of models (e.g., parallel composition, observer); (ii) diagnosis and opacity verification; (iii) common supervisory control functions (e.g., computation of supremal controllable and normal sublanguages); and (iv) more advanced functions on synthesis of attackers and of resilient supervisors in the presence of sensor deception attacks. The repository is a Git server maintained by the EECS Department at the University of Michigan, USA. Download from https://gitlab.eecs.umich.edu/M-DES-tools/desops.

4.2 IDES: An Open-Source Software Tool

IDES, the discrete-event systems software tool in Karen Rudie's lab is now available as open-source software at https://github.com/krudie/IDES. More information on IDES can also be found at https://www.ece.queensu.ca/people/K-Rudie/qdes.html#fndtn-software.

4.3 Supremica 2.7, New Version

The development team has just released a new version of Supremica, Waters/Supremica IDE 2.7.

Supremica is a DES and SCT drawing and calculation tool, that includes a multitude of efficient algorithms for modeling, verification, and synthesis of maximally permissive supervisors. In addition there are general algorithms for standard operations like synchronization, minimization, determinization, etc. Supremica also handles finite automata extended with bounded discrete variables. A feature-full simulation tool is also included.

New in this version:

- Conditional blocks or IF statements can now be created in the components list or on label blocks to allow conditional compilation of automata or events. They can also be used as an alternative to guard/action blocks.
- Update to Log4j 2.17.1 to avoid the Log4shell vulnerability.

Supremica is free to use for education and research; for commercial use, please contact fabian@chalmers.se. Download from www.supremica.org.

4.4 UltraDES 2.2 Release

UltraDES is an open-source library to the modeling, analysis and control of DES, written using C# in .NET Standard 2.0, which allows its use in multiple platforms, such as Windows, Linux, Mac, IOS, Android, so on. The library is under development at LACSED (Laboratory of Analysis and Control of Discrete Event Systems, at the Universidade Federal de Minas Gerais, Brazil) and has basic operations with automata as long as the monolithic, modular and local modular supervisory control (Alves et. al., 2017).

The main improvements of the UltraDES 2.2 version are:

- Supervisor Reduction Algorithm (Su and Wonham, 2004)
- Supervisor Localization (Cai and Wonham, 2010)
- Basic Petri Nets Functions (incidence matrix, coverability/reachability graph, Petri Net marking simulation, etc.)

Knowing that many researchers/students are not familiar with the C# language, we created an experimental python wrapper, that is less object oriented and easier to use.

Another initiative to improve the usability of UltraDES was the creation of a Web Application, developed using Blazor/WebAssembly, that allows the use of UltraDES online. This version is more limited in processing power and memory but it is useful for small examples and teaching.

We invite the community to download and contribute. Algorithms implemented may be integrated to the main distribution. Just let us know. Contact Lucas Alves lucasvra@ufmg.br or Patricia Pena ppena@ufmg.br for more information. Bugs should be informed using the UltraDES GitHub page.
Link: https://github.com/lacsed/UltraDES.

4.5 DESpot 1.10.0 Released

DESpot is a discrete-event system (DES) software, research tool. It supports both flat projects (collection of plant and supervisor DES), and Hierarchical Interface-Based Supervisory Control (HISC) projects.

DESpot 1.10.0 supports a number of new Features:

- DESpot now targets version 4.8.7 of the Qt libraries, RedHat Enterprise Linux 7.x, and MS Windows 10 with MS Visual Studios 2019.
- Support for defining template DES, and then instantiating multiple copies for flat or HISC projects.
- Now includes curved transition arrows for DES diagrams, and the ability to export DES diagrams to EPS.
- Support for verification of timed controllability, including BDD-based algorithms.
- Support for Fault-Tolerant (FT) Supervisory Control, including both timed and untimed controllability and nonblocking BDD-based algorithms, for several fault scenarios.
- Support for specifying decentralized supervisory control structure for a project, and verifying coobservability.

To find out more information and to download a copy, see: http://www.cas.mcmaster.ca/~leduc/DESpot.html

DESpot is open source software, released under the GNU General Public license (GPL), version 2.

DESpot is written in C++ and uses the QT GUI libraries. At the moment, DESpot is available as source code and as a Windows' installer. It runs under Linux, and Windows.

Back to the contents