IEEE CONTROL SYSTEMS SOCIETY TECHNICAL COMMITTEE ON DISCRETE EVENT SYSTEMS

Newsletter..... November 2018

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Contents:

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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

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

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

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

2.2 Technically Co-Sponsored activities

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

Selections of Journal Publications

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

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SELECTIONS OF THE IEEE TRANSACTIONS ON AUTOMATIC CONTROL
VOLUME: 63 ISSUE: 11
NOVEMBER 2018

(1) Minimization of Sensor Activation in Decentralized Discrete-Event Systems

Author: Xiang Yin ; Stéphane Lafortune

Abstract

We investigate the problem of dynamic sensor activation for decentralized decision making in partially observed discrete-event systems, where the system is monitored by a set of agents. The sensors of each agent can be turned on/off online dynamically according to a sensor activation policy. We define a general decentralized decision-making problem called the decentralized state disambiguation problem, which covers the decentralized control problem, the decentralized fault diagnosis problem, and the decentralized fault prognosis problem. The goal is to find a language-based minimal sensor activation policy for each agent such that the agents can always make a correct global decision as a team. A novel approach to solve this problem is proposed. We adopt a person-by-person approach to decompose this decentralized minimization problem into two centralized constrained minimization problems. Each centralized constrained minimization problem is then reduced to a fully centralized sensor activation problem that is solved effectively in the literature. The solution obtained is provably language-based minimal with respect to the system language.

Full-text available at: https://ieeexplore.ieee.org/document/8194858

(2) Composition of Least Restrictive Controllers, With Application to Collision Avoidance in Multiagent Systems

Author: Alessandro Colombo ; Fabio Della Rossa

Abstract

A supervisor (of a continuous-time or hybrid system) is a controller in charge of modifying the input assigned by a user or set of users to a system, in order to enforce a given specification. This paper describes conditions under which multiple supervisors, designed to enforce

different specifications, can be composed to obtain a supervisor enforcing the union of those specifications. As an application, we propose the composition of two supervisors, one enforcing collision avoidance of a large multiagent system, the other enforcing a second property, called sparsity, that allows efficient computation of the collision avoidance conditions.

Full-text available at: https://ieeexplore.ieee.org/document/8288683

(3) Sufficient Conditions for the Value Function and Optimal Strategy to be Even and Quasi-Convex

Author: Jhelum Chakravorty ; Aditya Mahajan

Abstract

Sufficient conditions are identified under which the value function and the optimal strategy of a Markov decision process (MDP) are even and quasi-convex in the state. The key idea behind these conditions is the following. First, sufficient conditions for the value function and optimal strategy to be even are identified. Next, it is shown that if the value function and optimal strategy are even, then one can construct a “folded MDP” defined only on the nonnegative values of the state space. Then, the standard sufficient conditions for the value function and optimal strategy to be monotone are “unfolded” to identify sufficient conditions for the value function and the optimal strategy to be quasi-convex. The results are illustrated by using an example of power allocation in remote estimation.

Full-text available at: https://ieeexplore.ieee.org/document/8278203

(4) Proper Policies in Infinite-State Stochastic Shortest Path Problems

Author: Dimitri P. Bertsekas

Abstract

We consider stochastic shortest path problems with infinite state and control spaces, a nonnegative cost per stage, and a termination state. We extend the notion of a proper policy, a policy that terminates within a finite expected number of steps, from the context of finite state space to the context of infinite state space. We consider the optimal cost function $J*$, and the optimal cost function $J\hat{}$ over just the proper policies. We show that $J*$ and $J\hat{}$ are the smallest and largest solutions of Bellman’s equation, respectively, within a suitable class of Lyapounov-like functions. If the cost per stage is bounded, these functions are those that are bounded over the effective domain of $J\hat{}$. The standard value iteration algorithm may be attracted to either $J*$ or $J\hat{}$, depending on the initial condition.

Full-text available at: https://ieeexplore.ieee.org/document/8309409

(5) Distributed Event-Triggered Communication and Control of Linear Multiagent Systems Under Tactile Communication

Author: Pian Yu ; Carlo Fischione ; Dimos V. Dimarogonas

Abstract

This note is concerned with the consensus of linear multiagent systems under tactile communication. Motivated by the emerging tactile communication technology where extremely low latency has to be supported, a distributed event-triggered communication and control scheme is proposed for the data reduction of each agent. First, an event-triggered data reduction scheme is designed for the communication between neighbors. Under such a communication scheme, a distributed event-triggered output feedback controller is further implemented for each agent, which is updated asynchronously with the communication action. It is proven that the consensus of the underlying multiagent systems is achieved asymptotically. Furthermore, it is shown that the proposed communication and control strategy fulfils the reduction of both the frequency of communication and controller updates as well as excluding Zeno behavior. A numerical example is given to illustrate the effectiveness of the proposed control strategy.

Full-text available at: https://ieeexplore.ieee.org/document/8290940

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SELECTIONS OF AUTOMATICA
VOLUME: 97
NOVEMBER 2018

(1) Detection and mitigation of classes of attacks in supervisory control systems

Author: Lilian Kawakam iCarvalho； Yi-Chin Wu； Raymond Kwong； Stéphane Lafortune

Abstract

The deployment of control systems with network-connected components has made feedback control systems vulnerable to attacks over the network. This paper considers the problem of intrusion detection and mitigation in supervisory control systems, where the attacker has the ability to enable or disable vulnerable actuator commands and erase or insert vulnerable sensor readings. We present a mathematical model for the system under certain classes of

actuator enablement attacks, sensor erasure attacks, or sensor insertion attacks. We then propose a defense strategy that aims to detect such attacks online and disables all controllable events after an attack is detected. We develop an algorithmic procedure for verifying whether the system can prevent damage from the attacks considered with the proposed defense strategy, where damage is modeled as the reachability of a pre-defined set of unsafe system states. The technical condition of interest that is necessary and sufficient in this context, termed “GF-safe controllability”, is characterized. We show that the verification of GF-safe controllability can be performed using diagnoser or verifier automata. Finally, we illustrate the methodology with a traffic control system example.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0005109818303741

(2) Change-point detection for piecewise deterministic Markov processes

Author: Alice Cleynen； Benoîtede Saporta

Abstract

We consider a change-point detection problem for a simple class of Piecewise Deterministic Markov Processes (PDMPs). A continuous-time PDMP is observed in discrete time and through noise, and the aim is to propose a numerical method to accurately detect both the date of the change of dynamics and the new regime after the change. To do so, we state the problem as an optimal stopping problem for a partially observed discrete-time Markov decision process taking values in a continuous state space and provide a discretization of the state space based on quantization to approximate the value function and build a tractable stopping policy. We provide error bounds for the approximation of the value function and numerical simulations to assess the performance of our candidate policy.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0005109818304011

(3) Probabilistically distorted risk-sensitive infinite-horizon dynamic programming

Author: Kun Lin; Cheng Jie; Steven I.Marcus

Abstract

Historically, the study of risk-sensitive criteria has focused on their normative applications — i.e., what should be done. The classic example is expected utility functions which produce deterministic policies. More recently, the literature on dynamic coherent risk measures has broadened the choices for risk-sensitive performance evaluation. However, coherent risk measures must be convex. This paper presents an alternative to both the expected utility and coherent risk measure approaches. This new approach, inspired by cumulative prospect

theory (CPT), is nonconvex and has substantial empirical evidence supporting its descriptive power for human decisions, i.e., what is actually done. A key unique feature of the CPT-based approach, essential for modeling human decisions, is probabilistic distortion. Hence, CPT should be used instead of both expected utility and coherent risk measures when modeling human decisions, which requires a higher level of expressiveness than allowed by previous work. In addition, although both coherent risk measures and CPT produce randomized policies, which are more robust against inaccurate probabilistic descriptions of systems, CPT generates policies that are significantly different from those of coherent risk measures.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0005109818303856

(4) Exact fault recovery for asynchronous sequential machines with output bursts

Author: Jung-Min Yang

Abstract

This paper presents an enhanced fault tolerant control strategy for a class of input/output asynchronous sequential machines (ASMs) in which output feedback takes the form of bursts. We design a corrective controller that counteracts any unauthorized state transition occurring to the ASM. As the controlled machine is steered on a feedback path, uncertainty about the goal state is reduced by the information that output bursts provide. Hence the use of output bursts in the correction procedure allows the controller to conduct more refined fault recovery than the case of accessing unit output characters as feedback. We present the existence condition and design procedure for a controller that achieves exact fault recovery, and provide an illustrative example to demonstrate the procedure of controller synthesis.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0005109818303911

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SELECTIONS OF DISCRETE EVENT DYNAMIC SYSTEMS: THEORY AND APPLICATIONS
VOLUME: 28 ISSUE: 4
NOVEMBER 2018

(1) Assigning multiple job types to parallel specialized servers

Author: Dinard van der Laan

Abstract

In this paper methods of mixing decision rules are investigated and applied to the so-called multiple job type assignment problem with specialized servers. This problem is modeled as continuous time Markov decision process. For this assignment problem performance optimization is in general considered to be difficult. Moreover, for optimal dynamic Markov decision policies the corresponding decision rules have in general a complicated structure not facilitating a smooth implementation. On the other hand optimization over the subclass of so-called static policies is known to be tractable. In the current paper a suitable static decision rule is mixed with dynamic decision rules which are selected such that these rules are relatively easy to describe and implement. Some mixing methods are discussed and optimization is performed over corresponding classes of so-called mixing policies. These mixing policies maintain the property that they are easy to describe and implement compared to overall optimal dynamic Markov decision policies. Besides for all investigated instances the optimized mixing policies perform substantially better than optimal static policies.

Full-text available at: https://link.springer.com/article/10.1007/s10626-018-0271-3

(2) Computing observers from observation policies in discrete-event systems

Author: David Sears；Karen Rudie

Abstract

This paper considers partially-observed discrete-event systems modeled by finite-state automata. The observation of event occurrences is associated with the transitions of the automaton model. That is, whether or not an event occurrence is observed is state-dependent, i.e., it depends on the transition in which the event label appears. This is in contrast to the case when observations are static and an event is either observed or not observed at every state in which it can occur. We refer to the set of transitions whose associated events are observed as an observation policy. Given an automaton model and an observation policy, we consider the problem of computing a deterministic generator of the language of event sequences that are observed using the automaton model and observation policy (i.e., an observer). Such a generator is useful, e.g., in problems of sensor activation for providing a deterministic mapping from event observations to sensor activation decisions when the decision to activate an event’s sensor is initially modeled as an observation policy. We propose an abstraction of the automaton model that may be used to represent an observer in certain cases. We illustrate cases where this abstraction accurately represents an observer when there is no ambiguity as to which event occurrences are observed following two observationally-identical strings. For the most general case considered, we demonstrate that verifying if the case holds is PSPACE-complete.

Full-text available at: https://link.springer.com/article/10.1007/s10626-018-0272-2

(3) Finite horizon continuous-time Markov decision processes with mean and variance criteria

Author: Yonghui Huang

Abstract

This paper studies mean maximization and variance minimization problems in finite horizon continuous-time Markov decision processes. The state and action spaces are assumed to be Borel spaces, while reward functions and transition rates are allowed to be unbounded. For the mean problem, we design a method called successive approximation, which enables us to prove the existence of a solution to the Hamilton-Jacobi-Bellman (HJB) equation, and then the existence of a mean-optimal policy under some growth and compact-continuity conditions. For the variance problem, using the first-jump analysis, we succeed in converting the second moment of the finite horizon reward to a mean of a finite horizon reward with new reward functions under suitable conditions, based on which the associated HJB equation for the variance problem and the existence of variance-optimal policies are established. Value iteration algorithms for computing mean- and variance-optimal policies are proposed.

Full-text available at: https://link.springer.com/article/10.1007/s10626-018-0273-1

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SELECTIONS OF THE IEEE TRANSACTIONS ON CONTROL SYSTEMS TECHNOLOGY
VOLUME: 26 ISSUE: 6
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(1) An Improved Mixed-Integer Programming Method to Compute Emptiable Minimal Siphons in S3PR Nets

Author: MengDi Gan ; ShouGuang Wang ; ZhiJun Ding ; MengChu Zhou ; Wenhui Wu

Abstract

Emptiable minimal siphons (EMSs) play a key role in the development of many deadlock control policies for resource allocation systems modeled with Petri nets. Recent research results show that siphon-based deadlock prevention methods can avoid complete siphon enumeration by using mixed-integer programming (MIP). This brief proposes a novel MIP approach, called MIP' for short, to compute EMSs for deadlock control in a class of Petri nets, i.e., a system of simple sequential processes with resources (S 3 PR). Compared with classical MIP, since MIP' utilizes the structural characteristics of S 3 PR nets to compute EMSs and more constraints are included in it, its solution space is drastically narrowed. As a

result, the number of iterations to solve the MIP' problem is significantly reduced, and the computational efficiency is considerably improved. Comparisons are provided on several S 3 PR nets to show its superior efficiency.

Full-text available at: https://ieeexplore.ieee.org/document/8068939

(2) Communication Schemes for Centralized and Decentralized Event-Triggered Control Systems

Author: Sokratis Kartakis ; Anqi Fu ; Manuel Mazo ; Julie A. McCann

Abstract

Energy constraint long-range wireless sensor/actuator-based solutions are theoretically the perfect choice to support the next generation of city-scale cyber-physical systems. Traditional systems adopt periodic control which increases network congestion and actuations while burdens the energy consumption. Recent control theory studies overcome these problems by introducing aperiodic strategies, such as event-triggered control (ETC). In spite of the potential savings, these strategies assume actuator continuous listening, while ignoring the sensing energy costs. In this paper, we fill this gap, by enabling sensing and actuator listening duty cycling and proposing two innovative medium access control protocols for three decentralized ETC approaches. A laboratory experimental test bed, which emulates a smart water network, was modeled and extended to evaluate the impact of system parameters and the performance of each approach. Experimental results reveal the predominance of the decentralized ETC against the classic periodic control either in terms of communication or actuation by promising significant system lifetime extension.

Full-text available at: https://ieeexplore.ieee.org/document/8061038

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