IEEE CONTROL SYSTEMS SOCIETY TECHNICAL COMMITTEE

ON DISCRETE EVENT SYSTEMS

Newsletter..... May 2015

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Editorial

Welcome to the newsletter of the IEEE Control Systems Technical

Committee on Discrete Event Systems!

Personal note from the editor:

WELCOME TO THE MAY 2015 NEWSLETTER.

SAMUEL

Activities

1) Sponsored Activities

2015 American Control Conference
Jul 1 to Jul 3, 2015, in the United States
http://acc2015.a2c2.org/

2015 IEEE Multi-Conference on Systems and Control (MSC)
Sep 21 to Sep 23, 2015, in Australia
http://www.msc2015.org/

54th IEEE Conference on Decision and Control
Dec 15 to Dec 18, 2015, in Japan
http://www.cdc2015.ctrl.titech.ac.jp/

2) Technically Co-Sponsored activities

The 27th Chinese Control and Decision Conference (2015CCDC)
May 23 to May 25, 2015, in China
http://www.ccdc.neu.edu.cn/

13th International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOpt 2015)
May 25 to May 29, 2015, in India
http://www.wi-opt.org/

Asian Control Conference 2015
May 31 to Jun 3, 2015, in Malaysia
http://ascc2015.com/

2015 International Conference on Unmanned Aircraft Systems (ICUAS '15)
Jun 9 to Jun 12, 2015, in United States
http://www.uasconferences.com/

23rd Mediterranean Conference on Control and Automation (MED2015)
Jun 16 to Jun 19, 2015, in Spain
http://med2015.uma.es/INDEX.PHP/

10th International Workshop on Robot Motion and Control - RoMoCo '15
Jul 6 to Jul 8, 2015, in Poland
http://romoco.put.poznan.pl/

ICINCO 2015 - 12th International Conference on Informatics in Control,

Automation and Robotics
Jul 21 to Jul 23, 2015, in France
http://www.icinco.org/

Journals

Contributed by: Zhenning Lang < langzn13@mails.tsinghua.edu.cn >

SELECTIONS FROM THE IEEE TRANSACTIONS ON AUTOMATIC CONTROL
VOLUME: 60 ISSUE: 5
MAY 2015

1) On Set-Valued Kalman Filtering and Its Application to Event-Based State Estimation

Dawei Shi, Tongwen Chen, Ling Shi

Abstract

Motivated by challenges in state estimation with event-based measurement updates, the properties of the exact and approximate set-valued Kalman filters with multiple sensor measurements for linear time-invariant systems are investigated in this work. First, we show that the exact and the proposed approximate set-valued filters are independent of the fusion sequence at each time instant. Second, the boundedness of the size of the set of estimation means is proved for the exact set-valued filter. For the approximate set-valued filter, if the closed-loop matrix is contractive, then the set of estimation means has a bounded size asymptotically; otherwise a nonsingular linear transform is constructed such that the size of the set of estimation means for the transformed states is asymptotically bounded. Third, the effect of set-valued measurements on the size of the set of estimation means is analyzed and conditions for performance improvement in terms of smaller size of the set of estimation means are proposed. Finally, the results are applied to event-based estimation, which allow the event-triggering conditions to be designed by considering requirements on performance and communication rates. The efficiency of the proposed results are illustrated by simulation examples and comparison with the approximate event-based MMSE estimator and the Kalman filter with intermittent observations.

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6954466&searchWithin%3Devent%26filter%3DAND%28p_IS_Number%3A7087408%29

2) Event-Based Control and Scheduling Codesign: Stochastic and Robust Approaches

Al-Areqi, S., Gorges, D., Liu, S.

Abstract

With the advent of networked embedded control systems (NECSs) new opportunities and challenges have arisen. Among others, the challenges result mostly from variable communication delays, access constraints, and resource constraints. An

event-based control and scheduling (EBCS) codesign strategy for NECSs involving a set of continuous-time LTI plants is proposed in this paper addressing all aforementioned challenges. A novel representation of the network-induced delay as an uncertain variable belonging to a finite set of different bounded intervals is further proposed. The transition from one bounded interval to another can be arbitrary or according to a stochastic process. Regarding the type of the transition and the resulting discrete-time switched polytopic system of the NECS, two versions of the EBCS problem are introduced: A robust EBCS problem under arbitrary transition and a stochastic EBCS problem under stochastic transition. Global uniform practical stability with guaranteed performance (measured by a quadratic cost function) is guaranteed for both versions after formulating them as LMI optimization problems. The effectiveness of the proposed EBCS strategy is illustrated along with a comparison between its versions for a set of mobile robots. Notably, the EBCS strategy is generally applicable to discrete-time switched polytopic systems.

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6955792&searchWithin%3Devent%26filter%3DAND%28p_IS_Number%3A7087408%29

3) Event-Based Leader-following Consensus of Multi-Agent Systems with Input Time Delay

Wei Zhu, Zhong-Ping Jiang

Abstract

The event-based control strategy is an effective methodology for tackling the distributed control of multi-agent systems with limited on-board resources. This technical note focuses on event-based leader-following consensus for multi-agent systems described by general linear models and subject to input time delay between controller and actuator. For each agent, the controller updates are event-based and only triggered at its own event times. A necessary condition and two sufficient conditions on leader-following consensus are presented, respectively. It is shown that continuous communication between neighboring agents can be avoided and the Zeno-behavior of triggering time sequences is excluded. A numerical example is presented to illustrate the effectiveness of the obtained theoretical results.

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6897941&searchWithin%3Devent%26filter%3DAND%28p_IS_Number%3A7087408%29

4) Suboptimal Event-Triggered Control for Time-Delayed Linear Systems

Wei Wu, S. Reimann, D. Gorges, S. Liu,

Abstract

This technical note considers event-triggering conditions and controller synthesis approaches for delayed linear systems. Optimization problems for minimizing the upper bound of quadratic cost functions are formulated in the form of linear matrix inequalities (LMIs). By solving the optimization problems a unique control gain can be obtained. The performance considered in this technical note includes a linear quadratic cost function for quantifying the control performance and average event times at which the control input must be

updated for quantifying the transmission reductions. Comparisons with other approaches in the literature are given to demonstrate the advantages with respect to the two performance indices. Furthermore, an experimental implementation of the proposed methods in an inverted pendulum system shows the applicability and effectiveness in real world.

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6876197&searchWithin%3Devent%26filter%3DAND%28p_IS_Number%3A7087408%29

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SELECTIONS FROM THE IEEE TRANSACTIONS ON CONTROL SYSTEMS TECHNOLOGY
VOLUME: 23 ISSUE: 3
MAY 2015

1) Markov Chain Approximation Algorithm for Event-Based State Estimation

Sangjin Lee, Weiyi Liu, Inseok Hwang

Abstract

This brief presents a general framework for the continuous-time nonlinear event-based state estimation problem. Using the information from observations made by event-based sampling, the goal of the event-based estimation problem is to estimate the state of stochastic differential equations which represent the uncertain system dynamics. This problem is challenging because measurements are taken only if some events happen rather than with a fixed sampling interval. In this brief, a theoretical solution for the event-based state estimation problem is derived and a numerical algorithm based on Markov chain approximation is proposed. The proposed algorithm for the event-based state estimation is demonstrated with an illustrative example.

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6906271&searchWithin%3Devent%26filter%3DAND%28p_IS_Number%3A7087415%29

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SELECTIONS FROM THE AUTOMATICA
VOLUME: 56
JUNE 2015

1) Supervisory control of discrete event systems with distinguishers

José E.R. Cury, Max Hering de Queiroz, Gustavo Bouzon, Marcelo Teixeira

Abstract

This paper deals with two relevant aspects of the Supervisory Control Problem (SCP) of Discrete Event Systems (DES): the degree of difficulty faced when modeling specifications to be fulfilled by the system under control, and the computational complexity of the synthesis procedure. The presented approach

consists in refining the set of events of a DES model into a new set. Each refinement is properly chosen to identify a particular instance of the original event in the system, which may simplify the modeling of specifications. A map named Distinguisher is then proposed to establish the relationship between strings of the original and refined alphabets. It is initially shown that using a refined set of events to solve a SCP directly leads to the optimal control solution, yet without providing computational advantages in synthesis with respect to the nonrefined method. Then, we propose the use of outer-approximations for the refined DES model as a way to reduce the cost of synthesis, while preserving controllability, least restrictiveness and nonblocking of the control solution. Two examples of manufacturing systems illustrate our results.

http://www.sciencedirect.com/science/article/pii/S0005109815001363

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SELECTIONS FROM THE DISCRETE EVENT DYNAMIC SYSTEMS: THEORY AND APPLICATIONS
VOLUME: 25 ISSUE: 3
SEPTEMBER 2015

1) Optimal control of hybrid switched systems: A brief survey

Feng Zhu, Panos J. Antsaklis

Abstract

This paper surveys recent results in the field of optimal control of hybrid and switched systems. We first summarize results that use different problem formulations and then explore the underlying relations among them. Specifically, based on the type of switching, we focus on two important classes of problems: internally forced switching (IFS) problems and externally forced switching (EFS) problems. For IFS problems, we focus on optimal control techniques for piecewise affine systems. For EFS problems, methodologies of two-stage optimization, embedding transformation and switching LQR design are investigated. Detailed optimization methods found in the literature are discussed.

http://link.springer.com/article/10.1007/s10626-014-0187-5

2) Simulating Markovian stochastic Petri Nets by difference equations with interval parameters

Kunihiko Hiraishi

Abstract

Fluid modeling is a technique for approximating behavior of stochastic discrete-state systems based on dynamical models with continuous state variables. In this paper, we focus on fluid modeling for Markovian stochastic Petri nets, and propose a method to compute regions including state values that appear with a high probability. This can be seen as the second-order approximation, because the size of each region varies according to the variance

of the corresponding state variable. The fluid models are represented by discrete-time dynamical systems with interval parameters, and interval arithmetic is used for computing regions at each time step. We show simulation results on the fluid models and compare the results with the correct solutions obtained by discrete-state analysis on stochastic Petri nets.

http://link.springer.com/article/10.1007/s10626-014-0188-4

3) Performance optimization for a class of generalized stochastic Petri nets

Ran Li, Spyros Reveliotis

Abstract

Motivated by the current scheduling needs of complex resource allocation systems, this paper introduces a novel methodology for performance optimization in DES applications that evolve over very large and complex state spaces and the main objective is expressed as the long-run maximization of some reward rate. The proposed methodology leverages the Generalized Stochastic Petri Net (GSPN) modeling framework in order to effect the seamless integration of the logical and performance-oriented control of the aforementioned applications, define a pertinent policy space, and (re-)cast the performance optimization problem into a mathematical programming formulation that is eventually solved through sensitivity analysis of Markov reward processes and stochastic approximation algorithms. An important attribute of the proposed methodology is that it facilitates an explicit control of the existing trade-off between the computational tractability of the employed formulation and the performance of the derived policies. Furthermore, by posing the eventually defined problem as a constrained nonlinear programming formulation, the presented methodology inherits all the analytical tools and insights that are offered by that vast area of optimization theory. In the current manuscript, all these possibilities are demonstrated through the application of the proposed approach to the throughput maximization of a capacitated re-entrant line abstracting the operation of an automated manufacturing cell.

http://link.springer.com/article/10.1007/s10626-014-0189-3

4) Fault model identification and synthesis in Petri nets

Maria Paola Cabasino, Alessandro Giua, Christoforos N. Hadjicostis, Carla Seatzu

Abstract

Fault identification studies in the Discrete Event Systems literature are typically model-based and require knowledge of the structure of the system, including the nature (and behavior) of the possible faults. In this paper we consider this problem within the framework of Petri nets assuming knowledge of the nominal (fault-free) system model but removing the requirement that the nature (or behavior) of the faults is known. Specifically, we consider a setting where faults are unobservable and use sequences of observations to infer the structure and behavior of faults. The resulting method recognizes the structure of the faulty system using knowledge of the structure of the fault-free system, and the projection of the faulty system language on the set of non-faulty events, which are assumed to be observable. Two problem formulations can be

given: (i) fault identification when the resulting faulty Petri net system is required to generate all observed sequences, while no constraint is imposed on sequences that are not observed; (ii) fault synthesis where the resulting faulty Petri net system is required to only generate all observed sequences, while all sequences that are not observed cannot actually occur. We show that a solution to the first problem can always be easily found, while the synthesis problem is not trivial at all and we solve it via an approach based on linear integer programming, which allows us to take into account physical constraints on the system in terms of possible and not possible interactions in the system.

http://link.springer.com/article/10.1007/s10626-014-0190-x

5) An accelerated stopping rule for the Nested Partition Hybrid Algorithm for discrete stochastic optimization

Joost Berkhout

Abstract

In this paper we present an accelerated stopping rule for improving the performance of the Nested Partition Hybrid Algorithm (NPHA), which is a general purpose algorithm for stochastic discrete optimization. Numerical examples will illustrate the impact of the accelerated stopping rule on the overall performance of NPHA.
http://link.springer.com/article/10.1007/s10626-014-0191-9

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SELECTIONS FROM THE IEEE TRANSACTIONS ON SYSTEMS, MAN, AND CYBERNETICS: SYSTEMS

VOLUME: 12 ISSUE: 2
APRIL 2015

1) Real-Time Production Scheduler for Digital-Print-Service Providers Based on a Dynamic Incremental Evolutionary Algorithm

Qing Duan, Jun Zeng, K. Chakrabarty, G. Dispoto

Abstract

We present a high-performance and real-time production scheduling algorithm for digital print production based on a dynamic incremental evolutionary algorithm. The optimization objective is to prioritize the dispatching sequence of orders and balance resource utilization. The scheduler is scalable for realistic problem instances and it provides solutions quickly for diverse print products that require complex fulfillment procedures. Furthermore, it dynamically ingests the transient state of the factory, such as process information and resource failure probability in print production; therefore, it minimizes the management-production mismatch. Discrete-event simulation results show that the production scheduler leads to a higher and more stable order on-time delivery ratio compared to a rule-based heuristic. Its beneficial attributes collectively contribute to the reduction or elimination of the shortcomings that are inherent

in today's digital printing environment and help to enhance a print factory's productivity and profitability.

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6750131&searchWithin%3Devent%26filter%3DAND%28p_IS_Number%3A7079441%29

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SELECTIONS FROM THE IEEE TRANSACTIONS ON HUMAN-MACHINE SYSTEMS
VOLUME: 45 ISSUE: 3
JUNE 2015

1) A Formal Transparency Framework for Validation of Real-Time Discrete-Event Control Requirements Modeled by Timed Transition Graphs

A. Dhananjayan, K.T. Seow

Abstract

In control of discrete-event systems, translating natural language control requirements into formal specifications in computable graphical form can be error prone, and system designers are often confronted with the longstanding problem of uncertainty in specification formalization, namely: How do we know that such a formalized specification is the one intended? This necessitates specification validation, i.e., manual inspection of the specification's graphical structure to clarify if it formalizes the intended requirement. The uncertainty is compounded in the specification formalization for timed discrete-event systems (TDESs) as timed transition graphs (TTGs), where real-time behavior also needs to be correctly specified. In the fundamental control framework of TDESs, a TTG prescribes a timed regulation of logical behavior restricting a TDES to some timed event-transition sequences. To help validate specification TTGs, we develop a new specification concept of TTG transparency. Our concept formulation embodies the essence of “summarizing” a specification TTG's transition sequences for a TDES, to highlight intermittent transitions essential or relevant for comprehending the specification's nontrivial timed restrictions. The transparency concept governs the reconstruction of a specification TTG into a transparent one. We investigate the problem of maximizing the transparency of specification TTGs for TDESs and show that it is NP-hard. We then develop a polynomial time algorithm for computing a highly transparent TTG. Through two examples, we show that the transparent TTG computed may support specification validation.

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7027213&searchWithin%3Devent%26filter%3DAND%28p_IS_Number%3A7106592%29

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SELECTIONS FROM THE INTERNATIONAL JOURNAL OF CONTROL
VOLUME: 88 ISSUE: 6
JUNE 2015

1) Distributed event-triggered consensus for multi-agent systems with quantisation

Zhiqiang Zhang, Lin Zhang, Fei Hao, Long Wang

Abstract

This paper studies the consensus problem for multi-agent systems with quantised information communication via event-triggered control. First, the asynchronous event-triggered control for multi-agent systems is considered based on distributed uniform-quantised protocols. It is shown that practical consensus among agents is guaranteed and occurrence of Zeno behaviour is prevented under the designed event-triggering mechanisms. Second, under the proposed protocols using logarithmic quantised information, both synchronous and asynchronous event-triggered control algorithms are given to solve the practical consensus problem. Meanwhile, Zeno behaviour of the closed-loop systems can be excluded under the proposed event-triggered algorithms. Finally, numerical simulations are given to illustrate the effectiveness of the derived results.

http://www.tandfonline.com/doi/full/10.1080/00207179.2014.994038#abstract

2) A design fix to supervisory control for fault-tolerant scheduling of real-time multiprocessor systems with aperiodic tasks

Rajesh Devaraj, Arnab Sarkar, Santosh Biswas

Abstract

In the article ‘Supervisory control for fault-tolerant scheduling of real-time multiprocessor systems with aperiodic tasks’, Park and Cho presented a systematic way of computing a largest fault-tolerant and schedulable language that provides information on whether the scheduler (i.e., supervisor) should accept or reject a newly arrived aperiodic task. The computation of such a language is mainly dependent on the task execution model presented in their paper. However, the task execution model is unable to capture the situation when the fault of a processor occurs even before the task has arrived. Consequently, a task execution model that does not capture this fact may possibly be assigned for execution on a faulty processor. This problem has been illustrated with an appropriate example. Then, the task execution model of Park and Cho has been modified to strengthen the requirement that none of the tasks are assigned for execution on a faulty processor.

http://www.tandfonline.com/doi/full/10.1080/00207179.2015.1039592#abstract

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