IEEE CONTROL SYSTEMS SOCIETY TECHNICAL COMMITTEE
ON DISCRETE EVENT SYSTEMS

Newsletter..... April 2015

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It is the responsibility of the contributor to ensure that they have the necessary permissions/clearance required for the transmittal of their news item.

Contents:

Editorial

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

Personal note from the editor:

WELCOME TO THE APRIL 2015 NEWSLETTER.

SAMUEL

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Activities

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1) Sponsored Activities

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

4th 2015 International Conference on Systems and Control (ICSC'15)
Apr 28 to Apr 30, 2015, in Tunisia
http://lias.labo.univ-poitiers.fr/icsc/icsc2015/

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/

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Journals

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

SELECTIONS FROM THE IEEE TRANSACTIONS ON AUTOMATIC CONTROL
VOLUME: 60 ISSUE: 4
APRIL 2015

1) A Framework for the Event-Triggered Stabilization of Nonlinear Systems

R. Postoyan, P. Tabuada, D. Nesic, A. Anta

Abstract

Event-triggered control consists of closing the feedback loop whenever a predefined state-

dependent criterion is satisfied. This paradigm is especially well suited for embedded systems

and networked control systems since it is able to reduce the amount of communication and

computation resources needed for control, compared to the traditional periodic implementation.

In this paper, we propose a framework for the event-triggered stabilization of nonlinear

systems using hybrid systems tools, that is general enough to encompass most of the existing

event-triggered control techniques, which we revisit and generalize. We also derive two new

event-triggering conditions which may further enlarge the inter-event times compared to the

available policies in the literature as illustrated by two physical examples. These novel

techniques exemplify the relevance of introducing additional variables for the design of the

triggering law. The proposed approach as well as the new event-triggering strategies are

flexible and we believe that they can be used to address other event-based control problems.

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6924753&searchWithin%3Devent

%26filter%3DAND%28p_IS_Number%3A7064679%29

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SELECTIONS FROM THE IEEE TRANSACTIONS ON CONTROL SYSTEMS TECHNOLOGY
VOLUME: 23 ISSUE: 2
MARCH 2015

1) A Petri Net-Based Discrete-Event Control of Automated Manufacturing Systems with Assembly

Operations

Hesuan Hu, MengChu Zhou

Abstract

In the context of automated manufacturing systems (AMSs), Petri nets are widely adopted to

solve the modeling, analysis, and control problems. So far, nearly all known approaches to

liveness-enforcing supervisory control study AMSs with flexible routes, whereas little work

investigates the ones with synchronization operations. Compared with flexibility,

synchronization allows the disassembly and assembly operations that correspond to splitting to

and merging from different subprocesses, respectively. Such structures bring difficulties to

establish a liveness condition of the Petri net model of AMSs. In this paper, we propose a

novel class of systems, which can well deal with these features so as to facilitate the

investigation of such complex systems. Using structural analysis, we show that their liveness

can be attributed to deadlock freeness, which is much easier to analyze, detect,

and control by

synthesizing a proper supervisory controller. Furthermore, a set of mathematical formulations

is proposed to describe and extract the corresponding deadlocks. This facilitates the synthesis

of liveness enforcing supervisors as it avoids the consideration of deadlock-free but nonlive

scenarios. The effectiveness and efficiency of this new method is shown by AMS examples.

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6880325&searchWithin%3Devent

%26filter%3DAND%28p_IS_Number%3A7042235%29

2) Symbolic Supervisory Control of Timed Discrete Event Systems

S. Miremadi, Zhennan Fei, K. Akesson, B. Lennartson

Abstract

We symbolically compute a nonblocking, controllable, and minimally restrictive supervisor for

timed discrete event systems (TDESs), in the supervisory control theory context. We model TDES

based on timed extended finite automata (TEFAs): an augmentation of extended finite automata

(EFAs) by incorporating discrete time into the model. EFAs are ordinary automata extended with

discrete variables, where conditional expressions and update functions can be attached to the

transitions. The controllability is defined based on the corresponding tick models of the

TEFAs. A tick can be considered as an event that is generated by a global digital clock. The

tick models suffer from a major problem: the state size is very sensitive to the clock

frequency. We show how a controllable supervisor, equivalent to the one computed based on the

tick models, can be obtained by eliminating the tick events. To tackle large problems, all

computations are conducted symbolically using binary decision diagrams (BDDs). We show that,

based on the proposed approach, a fixed point is reached earlier in the reachability analysis

and that the size of the intermediate BDDs usually becomes smaller. The framework has been

applied to a real industrial application and several benchmarks.

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%26filter%3DAND%28p_IS_Number%3A7042235%29

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SELECTIONS FROM THE AUTOMATICA
VOLUME: 55 ISSUE: 2
MAY 2015

1) Distributed convex optimization via continuous-time coordination algorithms with discrete-

time communication

Solmaz S. Kia, Jorge Cortés, Sonia Martínez

Abstract

This paper proposes a novel class of distributed continuous-time coordination algorithms to

solve network optimization problems whose cost function is a sum of local cost functions

associated to the individual agents. We establish the exponential convergence of the proposed

algorithm under (i) strongly connected and weight-balanced digraph topologies when the local

costs are strongly convex with globally Lipschitz gradients, and (ii) connected graph

topologies when the local costs are strongly convex with locally Lipschitz gradients. When the

local cost functions are convex and the global cost function is strictly convex, we establish

asymptotic convergence under connected graph topologies. We also characterize the algorithm’ s

correctness under time-varying interaction topologies and study its privacy preservation

properties. Motivated by practical considerations, we analyze the algorithm implementation with

discrete-time communication. We provide an upper bound on the stepsize that guarantees

exponential convergence over connected graphs for implementations with periodic communication.

Building on this result, we design a provably-correct centralized event-triggered communication

scheme that is free of Zeno behavior. Finally, we develop a distributed, asynchronous event-

triggered communication scheme that is also free of Zeno with asymptotic convergence

guarantees. Several simulations illustrate our results.

http://www.sciencedirect.com/science/article/pii/S0005109815001053?np=y

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SELECTIONS FROM THE CONTROL ENGINEERING PRACTICE
VOLUME 40
JULY 2015

1) A framework for hybrid model predictive control in mineral processing

Pablo Karelovic, Eduardo Putz, Aldo Cipriano

Abstract

Model Predictive Control (MPC) is an advanced technique for process control that has seen a

significant and widespread increase in its use in the process industry since its introduction.

In mineral processing, in particular, several applications of conventional MPC can be found for

the individual processes of crushing, grinding, flotation, thickening, agglomeration, and

smelting with varying degrees of success depending on the variables involved and the control

objectives. Given the complexity of the processes normally found in mineral processing, there

is also great interest in the design and development of advanced control techniques which aim

to deal with situations that conventional controllers are unable to do. In this aspect, Hybrid

MPC enables the representation of systems, incorporating logical variables, rules, and

continuous dynamics. This paper firstly presents a framework for modeling and representation of

hybrid systems, and the design and development of hybrid predictive controllers. Additionally,

two application examples in mineral processing are presented. Results through simulation show

that the control schemes developed under this framework exhibit a better performance when

compared with conventional expert or MPC controllers, while providing a highly systematized

methodology for the analysis, design, and development of hybrid MPC controllers.

http://www.sciencedirect.com/science/article/pii/S0967066115000398

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SELECTIONS FROM THE DISCRETE EVENT DYNAMIC SYSTEMS: THEORY AND APPLICATIONS
VOLUME 25, ISSUE 1-2
JUNE 2015

1) Multi-intersection Traffic Light Control with blocking

Yanfeng Geng, Christos G. Cassandras

Abstract

We address the traffic light control problem for multiple intersections in tandem by viewing it

in a stochastic hybrid system setting and developing a Stochastic Flow Model (SFM) for it. Our

model includes roads with finite vehicle capacity, which may lead to additional delays due to

traffic blocking. Using Infinitesimal Perturbation Analysis (IPA), we derive on-line gradient

estimators of an average traffic congestion metric with respect to the controllable green and

red cycle lengths. The IPA estimators obtained require counting traffic light switchings and

estimating car flow rates only when specific events occur. The estimators are used to

iteratively adjust light cycle lengths to improve performance and, in conjunction with a

standard gradient-based algorithm, to seek optimal values which adapt to changing traffic

conditions. Simulation results are included to illustrate the approach.

http://link.springer.com/article/10.1007/s10626-013-0176-0

2) Maximally permissive deadlock avoidance for resource allocation systems with R/W-locks

Ahmed Nazeem, Spyros Reveliotis

Abstract

This paper extends the existing theory on maximally permissive liveness-enforcing supervision

of resource allocation systems (RAS) so that it can handle RAS with reader / writer (R/W-)

locks. A key challenge that is posed by this new RAS class stems from the fact that the

underlying state space is not necessarily finite. We effectively address this obstacle by

taking advantage of special structure that exists in the set of inadmissible states and enables

a finite representation of this set through its minimal elements.

http://link.springer.com/article/10.1007/s10626-014-0202-x

3) Coordination control of discrete-event systems revisited

Jan Komenda, Tomá? Masopust, Jan H. van Schuppen

Abstract

In this paper, we revise and further investigate the coordination control approach proposed for

supervisory control of distributed discrete-event systems with synchronous communication based

on the Ramadge-Wonham automata framework. The notions of conditional decomposability,

conditional controllability, and conditional closedness ensuring the existence of a solution

are carefully revised and simplified. The approach is generalized to non-prefix-closed

languages, that is, supremal conditionally controllable sublanguages of not necessary prefix-

closed languages are discussed. Non-prefix-closed languages introduce the blocking issue into

coordination control, hence a procedure to compute a coordinator for nonblockingness is

included. The optimization problem concerning the size of a coordinator is under investigation.

We prove that to find the minimal extension of the coordinator event set for which a given

specification language is conditionally decomposable is NP-hard. In other words, unless P=NP,

it is not possible to find a polynomial algorithm to compute the minimal coordinator with

respect to the number of events.

http://link.springer.com/article/10.1007/s10626-013-0179-x

4) A hierarchical and modular control architecture for sequential behaviours

Christine Baier, Thomas Moor

Abstract

This paper develops a hierarchical and modular control architecture for so called sequential

behaviours, i.e. for plant dynamics and specifications that are represented as formal languages

of infinite-length words. Our main result is the elaboration of structural properties that

allow for abstraction based controller design and that are preserved under closed-loop

composition. Thus, we propose to alternate controller design, closed-loop composition and

abstraction in order to construct a hierarchical control system in a bottom-up fashion. When

the overall plant is composed from a number of components, our approach naturally extends to

the alternation of controller design, closed-loop composition, abstraction and component

composition. Technically, our results are based on the notion of input-output systems known

from behavioural systems theory, with a particular focus on liveness properties represented as

sequential behaviours that are not necessarily topologically closed.

http://link.springer.com/article/10.1007/s10626-014-0182-x

5) Computation of supervisors for reconfigurable machine tools

Klaus Werner Schmidt

Abstract

The rapid reconfiguration of manufacturing systems is an important issue in today’s

manufacturing technology in order to adjust the production to varying product demands and

types. In this paper, we study the control of reconfigurable machine tools (RMTs) with the aim

of fast reconfiguration and an easy controller implementation. We first formulate a particular

reconfiguration problem for RMTs in a discrete event system setting, and then provide a

necessary and sufficient condition for its solution. Moreover, we propose a polynomial-time

algorithm for the construction of a reconfiguration supervisor as the composition of one

modular supervisor for each separate RMT configuration. Each modular supervisor operates in

three modes. In the first mode, it tracks the plant state if its corresponding configuration is

inactive. In the second mode, it performs a configuration change if its corresponding

configuration becomes active and in the third mode, it follows the specified behavior of its

corresponding configuration if the configuration is active. An important property of the

proposed reconfiguration supervisor is that it performs reconfigurations in a bounded number of

event occurrences. In addition, the modular realization of our reconfiguration supervisor

enables controller modifications such as adding or removing configurations during run-time. All

results presented in the paper are illustrated by an RMT example.

http://link.springer.com/article/10.1007/s10626-014-0183-9

6) Robustness of synchronous communication protocols with delay for decentralized discrete-

event control

Waselul Haque Sadid, Laurie Ricker, Shahin Hashtrudi-Zad

Abstract

Recent work on modeling communication delay between communicating decentralized discrete-event

controllers only considers the case when all observations are communicated. When this condition

is relaxed, it may yet be possible to formulate communicating decentralized controllers that

can solve the control problem. Instead of synthesizing reduced communication protocols under

conditions of delay, synchronous communication protocols (where not all observations are

communicated) are examined for their robustness under conditions when either the exact delay is

known or only the upper bound for the delay is known.

http://link.springer.com/article/10.1007/s10626-014-0184-8

6) Hierarchical modelling of manufacturing systems using discrete event systems and the

conflict preorder

Robi Malik, Ryan Leduc

Abstract

This paper introduces Hierarchical Interface-Based Supervisory Control using the Conflict

Preorder and applies it to the design of two manufacturing systems models of practical scale.

Hierarchical Interface-Based Supervisory Control decomposes a large system into subsystems

linked to each other by interfaces, facilitating the design of complex systems and the re-use

of components. By ensuring that each subsystem satisfies its interface consistency conditions

locally, it can be ensured that the complete system is controllable and nonblocking. The

interface consistency conditions proposed in this paper are based on the conflict preorder,

providing increased flexibility over previous approaches. The framework requires only a small

number of interface consistency conditions, and allows for the design of multi-level

hierarchies that are provably controllable and nonblocking.

http://link.springer.com/article/10.1007/s10626-014-0185-7

7) New results on supervisor localization, with case studies

Kai Cai, W. M. Wonham

Abstract

Recently we developed supervisor localization, a top-down approach to distributed control of

discrete-event systems in the Ramadge-Wonham supervisory control framework. Its essence is the

allocation of monolithic (global) control action among the local control strategies of

individual agents. In this paper, we start by presenting several refinements of our

localization theory. First, we drop the original assumption that the event sets of component

agents are pairwise disjoint. Second, we show that consistent marking information can be

enforced by just one agent, which can be selected arbitrarily. Third, the event sets of

localized controllers are explicitly defined, in general as proper subsets of the entire event

set. For these generalizations, we again prove that the collective local controlled behavior is

identical to the global optimal and nonblocking controlled behavior. Moreover, we provide a

language interpretation of localization by relating the key concept of control cover/congruence

on the supervisor’ s state set to a special right congruence on the supervisor’ s language.W e

go on to apply the extended supervisor localization to solve a multi-agent formation problem.

We introduce a suitable formulation of formation invariance as well as shortest paths to

formation. Local strategies are synthesized for a group of agents to arrive at a pre-specified

formation in shortest paths; then issues of information exchange and control logic are

examined. We further demonstrate the extended localization on a large-scale Cluster Tool

example. By first synthesizing a set of decentralized supervisors and coordinators by an

efficient heterarchical approach, our localization yields a distributed control architecture

with comprehensible local control/coordination logic.

http://link.springer.com/article/10.1007/s10626-014-0194-6

8) Employing behavioral preorders to define controllability for nondeterministic discrete-event

systems

Jasen Markovski

Abstract

We employ the behavioral preorder termed partial bisimulation to define controllability for

nondeterministic discrete-event systems. The preorder induces a refinements relation between

the models of the controlled and the original system, that captures a notion of

controllability. We define a notion of a model of a deterministic supervisory controller and we

compare our approach to existing ones in the literature. We show that the equivalence relation,

induced by the partial bisimulation preorder, can be employed to minimize the model of the

unsupervised system. We develop an efficient minimization algorithm, by characterizing the

preorders as partition-relation pairs under stability conditions.

http://link.springer.com/article/10.1007/s10626-014-0201-y

9) Diagnosis and opacity problems for infinite state systems modeled by recursive tile systems

Sébastien Chédor, Christophe Morvan, Sophie Pinchinat, Hervé Marchand

Abstract

The analysis of discrete event systems under partial observation is an important topic, with

major applications such as the detection of information flow and the diagnosis of faulty

behaviors. These questions have, mostly, not been addressed for classical models of recursive

systems, such as pushdown systems and recursive state machines. In this paper, we consider

recursive tile systems, which are recursive infinite systems generated by a finite collection

of finite tiles, a simplified variant of deterministic graph grammars (slightly more general

than pushdown systems). Since these systems are infinite-state in general powerset

constructions for monitoring do not always apply. We exhibit computable conditions on recursive

tile systems and present non-trivial constructions that yield effective computation of the

monitors. We apply these results to the classic problems of state-based opacity and

diagnosability (off-line verification of opacity and diagnosability, and also run-time

monitoring of these properties). For a decidable subclass of recursive tile systems, we also

establish the decidability of the problems of state-based opacity and diagnosability.

http://link.springer.com/article/10.1007/s10626-014-0197-3

10) New representations for (max,+) automata with applications to performance evaluation and

control of discrete event systems

Rabah Boukra, Sébastien Lahaye, Jean-Louis Boimond

Abstract

A large class of timed discrete event systems can be modeled by means of (max,+) automata, that

is automata with weights in the so-called (max,+) algebra. In this contribution, specific

recursive equations over (max,+) and (min,+) algebras are shown to be suitable for describing

extremal behaviors of (max,+) automata. Several pertinent performance indicators can be easily

derived or approximated from these representations with a low computation complexity. It is

also shown how to define inputs which model exogenous influences on their

dynamic evolution,

and a new approach for the control of (max,+) automata is proposed.

http://link.springer.com/article/10.1007/s10626-013-0178-y

11) Compositions of (max, +) automata

Sébastien Lahaye, Jan Komenda, Jean-Louis Boimond

Abstract
This paper presents a compositional modeling approach by means of (max, +) automata. The

motivation is to be able to model a complex discrete event system by composing sub-models

representing its elementary parts. A direct modeling of safe timed Petri nets using (max, +)

automata is first introduced. Based on this result, two types of synchronous product of (max,

+) automata are proposed to model safe timed Petri nets obtained by merging places and/or

transitions in subnets. An asynchronous product is finally proposed to represent particular

bounded timed Petri nets.

http://link.springer.com/article/10.1007/s10626-014-0186-6

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SELECTIONS FROM THE INTERNATIONAL JOURNAL OF CONTROL
VOLUME 88, ISSUE 5

1) State feedback control of real-time discrete event systems with infinite states

Seong-Jin Park, Kwang-Hyun Cho

Abstract

In this paper, we study a state feedback supervisory control of timed discrete event systems

(TDESs) with infinite number of states modelled as timed automata. To this end, we represent a

timed automaton with infinite number of untimed states (called locations) by a

finite set of

conditional assignment statements. Predicates and predicate transformers are employed to

finitely represent the behaviour and specification of a TDES with infinite number of locations.

In addition, the notion of clock regions in timed automata is used to identify the reachable

states of a TDES with an infinite time space. For a real-time specification described as a

predicate, we present the controllability condition for the existence of a state feedback

supervisor that restricts the behaviour of the controlled TDES within the specification.

http://www.tandfonline.com/doi/full/10.1080/00207179.2014.993712#abstract

2) Decentralized fault diagnosis approach without a global model for fault diagnosis of

discrete event systems

Moamar Sayed-Mouchaweh, Edwin Lughofer

Abstract

Diagnosability property ensures that a predefined set of faults are diagnosable by a

centralized diagnoser built using a global model of the system; while co-diagnosability

guarantees that these faults are diagnosed in decentralized manner using a set of local

diagnosers. A fault must be diagnosed by at least one local diagnoser by using its proper local

observation of the system. The aim of using decentralized diagnosis approaches is to overcome

the space complexity and weak robustness of centralized diagnosis approaches while at the same

time preserving the diagnostic capability of a centralized diagnosis. However, co-

diagnosability property is stronger than diagnosability property. If a system is co-

diagnosable, then it is diagnosable; while a diagnosable system does not ensure that it is co-

diagnosable. Therefore, the challenge of decentralized diagnosis approaches is to perform local

diagnosis and to verify that it is equivalent to the centralized one without the need for a

global model. In this paper, an approach is proposed to obtain co-diagnosable decentralized

diagnosis structure of discrete event systems without the use of a global model. This approach

is based on the synchronization of local diagnosis decisions in order to solve the ambiguity

between local diagnosers. This synchronization allows obtaining local diagnosis equivalent to

the global one without the use of a global model.

http://www.tandfonline.com/doi/abs/10.1080/00207179.2015.1039594#abstract

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The End

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