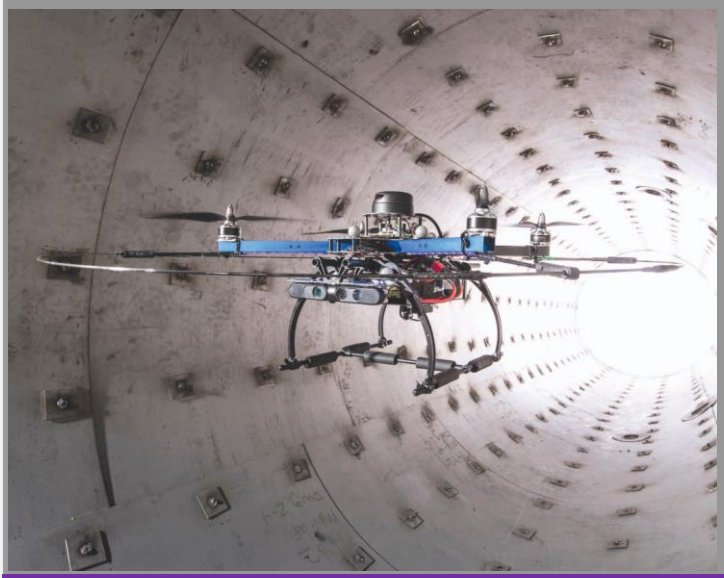
Control Systems Society



PUBLICATIONS CONTENT DIGEST

CSS Publications Activities

Vice-President

THOMAS PARISINI *Imperial College London and University of Trieste*
http://www.ieeecss.org/publications/css-publications

Journal Editors

IEEE Transactions on Automatic Control

ALESSANDRO ASTOLFI *Imperial College London and University of Rome "Tor Vergata"*
http://www.ieeecss.org/publications/tac

IEEE Transactions on Control Systems Technology

ANDREA SERRANI *Ohio State University*
http://www.ieeecss.org/publications/tcst

IEEE Transactions on Control of Network Systems

IOANNIS PASCHALIDIS *Boston University*

JEFF SHAMMA Deputy Editor-in-Chief *King Abdullah University of Science and Technology*
http://www.ieeecss.org/publications/transactions-control-network-systems

IEEE Control Systems Magazine

JONATHAN HOW *Massachusetts Institute of Technology*
http://www.ieeecss.org/publications/csm

IEEE Control Systems Letters

MARIA ELENA VALCHER *University of Padua*
http://ieee-cssletters.dei.unipd.it/index.php

Electronics Editor

E-letter on Systems, Control and Signal Processing

JIANGHAI HU *Purdue University*
http://www.ieeecss.org/publications/e-letter/e-letter

***Submission and editorial instructions can be found on each publication's homepage**
For subscription to the monthly E-Letter, please visit:
http://www.ieeecss.org/newsletter/subscriptions

IEEE TRANSACTIONS ON

AUTOMATIC CONTROL

A PUBLICATION OF THE IEEE CONTROL SYSTEMS SOCIETY

AUGUST 2018 VOLUME 63 NUMBER 8 IETAA9 (ISSN 0018-9286)

Scanning the Issue 2309

REGULAR PAPERS

Dynamic Distributed Control for Networks With Cooperative–Antagonistic Interactions ..... *D. Meng* 2311
Stochastic Games for the Smart Grid Energy Management With Prospect Prosumers ..... *S. R. Etesami, W. Saad, N. B. Mandayam, and H. V. Poor* 2327
Deadline Scheduling as Restless Bandits ..... *Z. Yu, Y. Xu, and L. Tong* 2343
Ranking and Selection as Stochastic Control ..... *Y. Peng, E. K. P. Chong, C.-H. Chen, and M. C. Fu* 2359
Event-Triggered Second-Moment Stabilization of Linear Systems Under Packet Drops ..... *P. Tallapragada, M. Franceschetti, and J. Cortés* 2374
Asymptotic Consensus on the Average of a Field for Time-Varying Nonlinear Networks Under Almost Periodic Connectivity ..... *S. Manfredi and D. Angeli* 2389
Model Reference Adaptive Control of 2×2 Coupled Linear Hyperbolic PDEs ..... *H. Anfinsen and O. M. Aamo* 2405
Two-Sided Boundary Stabilization of Heterodirectional Linear Coupled Hyperbolic PDEs ..... *J. Auriol and F. Di Meglio* 2421
Optimal Mechanisms for Robust Coordination in Congestion Games ..... *P. N. Brown and J. R. Marden* 2437
The Role of Convexity in Saddle-Point Dynamics: Lyapunov Function and Robustness ..... *A. Cherukuri, E. Mallada, S. Low, and J. Cortés* 2449
Feedback Particle Filter on Riemannian Manifolds and Matrix Lie Groups ..... *C. Zhang, A. Taghvaei, and P. G. Mehta* 2465
A Multivariable Stochastic Tracking Controller for Robot Manipulators Without Joint Velocities ..... *S. S. Saab and P. Ghanem* 2481
$\mathcal{L}_2$-Gain for Hybrid Linear Systems With Periodic Jumps: A Game Theoretic Approach for Analysis and Design ..... *C. Possieri and M. Sassano* 2496
Resilient Randomized Quantized Consensus ..... *S. M. Dibaji, H. Ishii, and R. Tempo* 2508
Design of Feedback Control Laws for Information Transfer in Spintronics Networks ..... *S. G. Schirmer, E. A. Jonckheere, and F. C. Langbein* 2523
Event-Triggered Output Feedback Stabilization via Dynamic High-Gain Scaling ..... *J. Peralez, V. Andrieu, M. Nadri, and U. Serres* 2537

(Contents Continued on Back Cover)

(Contents Continued from Front Cover)

TECHNICAL NOTES

Near-Optimal Scheduling for Petri Net Models With Forbidden Markings ..... *D. Lefebvre* 2550
A Set-Theoretic Reconfiguration Feedback Control Scheme Against Simultaneous Stuck Actuators ..... *W. Lucia, D. Famularo, and G. Franzè* 2558
H_2 Analysis of LTI Systems via Conversion to Externally Positive Systems ..... *Y. Ebihara* 2566
Performance Optimization for Timed Weighted Marked Graphs Under Infinite Server Semantics ..... *Z. He, Z. Li, and A. Giua* 2573
Multipattern Output Consensus in Networks of Heterogeneous Nonlinear Agents With Uncertain Leader: A Nonlinear Regression Approach ..... *G. Casadei and D. Astolfi* 2581
H_2 Output-Feedback Control With Finite Multiple Measurement Information ..... *C. K. Ahn, P. Shi, and H. Li* 2588
Secure State Estimation Against Sparse Sensor Attacks With Adaptive Switching Mechanism ..... *L. An and G.-H. Yang* 2596
Leader-Following Consensus of Multiple Uncertain Euler–Lagrange Systems Subject to Communication Delays and Switching Networks ..... *M. Lu and L. Liu* 2604
Matrix Optimal Mass Transport: A Quantum Mechanical Approach ..... *Y. Chen, T. T. Georgiou, and A. Tannenbaum* 2612
Robust State Feedback Regulator Design for General Linear Heterodirectional Hyperbolic Systems ..... *J. Deutscher and J. Gabriel* 2620
Converse Theorems for Safety and Barrier Certificates ..... *S. Ratschan* 2628
Boundary Feedback Stabilization of a Class of Coupled Hyperbolic Equations With Nonlocal Terms ..... *L. Su, J.-M. Wang, and M. Krstic* 2633
Bounds on the Smallest Eigenvalue of a Pinned Laplacian Matrix ..... *S. Manaffam and A. Behal* 2641
Quasi-Time-Dependent Output Control for Discrete-Time Switched System With Mode-Dependent Average Dwell Time ..... *Z. Fei, S. Shi, Z. Wang, and L. Wu* 2647
Global Asymptotic Stability of a PID Control System With Coulomb Friction ..... *A. Bisoffi, M. Da Lio, A. R. Teel, and L. Zaccarian* 2654
A Cascades Approach to Formation-Tracking Stabilization of Force-Controlled Autonomous Vehicles ..... *M. Maghenem, A. Loría, and E. Panteley* 2662
Distributed Algorithm for Solving Convex Inequalities ..... *K. Lu, G. Jing, and L. Wang* 2670
Distance-Based Control of $\mathcal{K}_n$ Formations in General Space With Almost Global Convergence ..... *M.-C. Park, Z. Sun, B. D. O. Anderson, and H.-S. Ahn* 2678
Event-Based Boundary Control of a Linear 2×2 Hyperbolic System via Backstepping Approach ..... *N. Espitia, A. Girard, N. Marchand, and C. Prieur* 2686
Exponential Stability of Two-Dimensional Homogeneous Monotone Systems With Bounded Directional Delays ..... *L. V. Hien and H. Trinh* 2694
On Kalman-Consensus Filtering With Random Link Failures Over Sensor Networks ..... *Q. Liu, Z. Wang, X. He, and D. H. Zhou* 2701
Slow State Variables Feedback Stabilization for Semi-Markov Jump Systems With Singular Perturbations ..... *H. Shen, F. Li, S. Xu, and V. Sreeram* 2709
Passivity-Based Asynchronous Sliding Mode Control for Delayed Singular Markovian Jump Systems ..... *F. Li, C. Du, C. Yang, and W. Gui* 2715
Linear–Quadratic Mean-Field Game for Stochastic Delayed Systems ..... *J. Huang and N. Li* 2722
Distributed Circular Formation Control of Nonholonomic Vehicles Without Direct Distance Measurements ..... *X. Yu, L. Liu, and G. Feng* 2730
Global Exponential/Finite-Time Stability of Nonlinear Adaptive Switching Systems With Applications in Controlling Systems With Unknown Control Direction ..... *W. Chen, C. Wen, and J. Wu* 2738
Comments on "On Stabilization of 2-D Roesser Models" ..... *O. Bachelier, W. Paszke, N. Yeganefar, and D. Mehdi* 2745

ERRATA

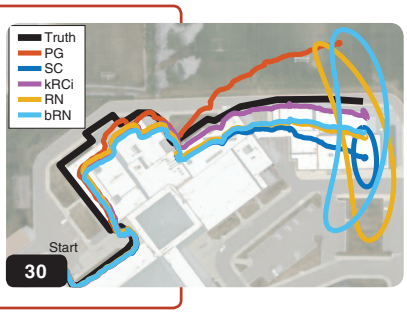
Errata to "Multivalued Robust Tracking Control of Lagrange Systems: Continuous and Discrete-Time Algorithms" ..... *F. Miranda, B. Brogliato, and F. Castaños* 2750

IEEE control systems MAGAZINE

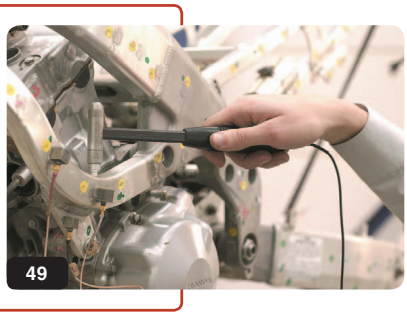
August 2018 Volume 38 Number 4

WWW.IEEECSS.ORG/PUBLICATIONS/CSM

FEATURES



30 Relative Navigation
A keyframe-based approach for observable GPS-degraded navigation
DAVID O. WHEELER, DANIEL P. KOCH, JAMES S. JACKSON, TIMOTHY W. MCLAIN, AND RANDAL W. BEARD



49 Nonparametric Data-Driven Modeling of Linear Systems
Estimating the frequency response and impulse response function
JOHAN SCHOUKENS, KEITH GODFREY, AND MAARTEN SCHOUKENS

89 The Explicit Reference Governor
A general framework for the closed-form control of constrained nonlinear systems
MARCO M. NICOTRA AND EMANUELE GARONE

DEPARTMENTS

Cover credit: A Brigham Young University quadrotor preparing to explore a heatstack. Image courtesy of David Wheeler, Daniel Koch, James Jackson, Timothy McLain, and Randal Beard.

3 FROM THE EDITOR
Control Systems Reproducibility Challenge

5 ABOUT THIS ISSUE
GPS-Degraded Navigation

8 PRESIDENT'S MESSAGE
Nurturing Diversity and Reducing Implicit Evaluation Bias

11 CSS NEWS

12 25 YEARS AGO

14 FEEDBACK

Digital Object Identifier 10.1109/MCS.2017.2770302

» DEPARTMENTS

111

15 MEMBER ACTIVITIES
IEEE, Control Systems Society, and Women in Engineering in Ecuador

17 TECHNICAL ACTIVITIES
Technical Committee on Variable Structure and Sliding Mode Control

Technical Committee on Networks and Communication Systems

20 PEOPLE IN CONTROL
Hitay Özbay

Giuseppe C. Calafiore

Karen G. Rudie

Mark E. Campbell

108 BOOKSHELF
Book Announcements

111 CONFERENCE REPORTS
Thirty Years of the Ramadge–Wonham Theory of Supervisory Control

Workshop on Emerging Applications of Control and System Theory (EACST)

115 CONFERENCE CALENDAR

COV3 ON THE LIGHTER SIDE
Why Not Symbols?

SUSTAINABLE FORESTRY INITIATIVE Certified Chain of Custody Promoting Sustainable Forestry www.sfiprogram.org SFI-01681

IEEE PERIODICALS MAGAZINES DEPARTMENT
445 Hoes Lane, Piscataway, NJ 08854 USA

Senior Managing Editor
Geraldine Krolin-Taylor

Senior Art Director
Janet Dudar

Associate Art Director
Gail A. Schnitzer

Production Coordinator
Theresa L. Smith

Advertising Production Manager
Felicia Spagnoli

Production Director
Peter M. Tuohy

Director, Business Development — Media & Advertising
Mark David

Editorial Services Director
Kevin Lisankie

Staff Director Publishing Operations
Dawn M. Melley

IEEE prohibits discrimination, harassment, and bullying. For more information, visit http://www.ieee.org/web/aboutus/whatis/policies/p9-26.html.

MISSION STATEMENT AND SCOPE: As the official means of communication for the IEEE Control Systems Society, *IEEE Control Systems Magazine* publishes interesting, useful, and informative material on all aspects of control system technology for the benefit of control educators, practitioners, and researchers. With this mission statement in mind, *IEEE Control Systems Magazine* encourages submissions, both feature articles and columns, on all aspects of control system technology.

SUBMISSION OF MANUSCRIPTS: A feature article typically provides an in-depth treatment of either an application of control technology, a tutorial on some area of control theory, or an innovation in control education.

IEEE Control Systems Magazine publishes a variety of columns. "Applications of Control" columns are industrially oriented summaries of innovations in control technology. "Focus on Education" typically describes some aspect of education such as novel control experiments. "Lecture Notes" can be theoretical in nature as long as they have clear tutorial value and intent. See recent issues for examples of these and other types of columns. Authors are encouraged to contact the editor-in-chief about the suitability of potential columns.

A detailed Author's Guide, a sample formatted manuscript, and LATEX template can be found at http://www.ieeecss.org/publications/csm/submissions. The specifications in this Guide should be followed by all submissions.

All manuscripts should be submitted electronically to the *IEEE Control Systems Magazine* website, https://css.paperplaza.net/conferences/scripts/start.pl, with inquiries on appropriateness of content emailed to jhow@mit.edu.

SPECIAL ISSUES: *IEEE Control Systems Magazine* encourages proposals for special issues. Proposers are encouraged to contact the editor-in-chief to discuss potential topics.

BOOKS AND CONFERENCES: Submit information about recently published books to the associate editor for book reviews. Submit information about past and future conferences to the corresponding editor for conferences.

ADVERTISING: *IEEE Control Systems Magazine* accepts advertising for educational products, books, software, conferences, employment, and control-related technology. For information about advertising, contact Mark David, m.david@ieee.org, +1 732 465 6473.

IEEE CONTROL SYSTEMS MAGAZINE—(ISSN 1066-033X) (ISMAD7) is published bimonthly by The Institute of Electrical and Electronics Engineers, Inc. Headquarters: 3 Park Avenue, 17th Floor, New York, NY 10016-5997, U.S.A. +1 212 419 7900. Responsibility for the contents rests upon the authors and not upon the IEEE, the Society, or its members. The magazine is a membership benefit of the IEEE Control Systems Society, and subscriptions are US$4.00 per member per year (included in Society fee). Replacement copies for members are available for US$20.00 (one copy only). Nonmembers can purchase individual copies for US$106.00. Nonmember subscription prices are available on request.

Copyright and Reprint Permissions: Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limits of the U.S. Copyright law for private use of patrons: 1) those post-1977 articles that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01970, U.S.A.; and 2) pre-1978 articles without fee. For other copying, reprint, or republication permission, write to: Copyrights and Permissions Department, IEEE Service Center, 445 Hoes Lane, Piscataway NJ 08854, U.S.A. Copyright © 2018 by The Institute of Electrical and Electronics Engineers, Inc. All rights reserved.

Periodicals postage paid at New York, NY and at additional mailing offices. Postmaster: Send address changes to *IEEE Control Systems Magazine*, IEEE, 445 Hoes Lane, Piscataway, NJ 08854 U.S.A. Canadian GST #125634188

Printed in U.S.A

UPCOMING CONFERENCES

Important Dates

Paper Submissions Open:
November 1, 2017

Invited Session Proposals Due:
~~January 15, 2018~~ (PASSED)

Contributed and Invited Papers Due:
~~January 15, 2018~~ (PASSED)

Acceptance Notice:
April 23, 2018

Final Submissions Due:
~~May 21, 2018~~ (PASSED)

CONFERENCE ON TECHNOLOGY AND APPLICATIONS

AUGUST 21-24, 2018
Copenhagen, Denmark

CCTA 2018 will be held at the Scandic Hotel Copenhagen Scandic Copenhagen is located in central Copenhagen, with views of one of the three lakes and the city, and close to the Tivoli Gardens and the pedestrian street, Strøget. With its leafy parklands and canal side living, Copenhagen is a green and liveable city to visit. Summer jazz and street food markets fill the city during summer months, and there is never far to a sandy beach or harbour bar.

http://ccta2018.ieeecss.org/

DECEMBER 17-19, 2018

MIAMI, FLORIDA, USA

Conference on Decision and Control

Important Dates

Invited Session Proposals Due:
~~March 10, 2018~~ (Passed)

Paper Submissions Due:
~~March 20, 2018~~ (Passed)

Workshop Proposals Due:
~~May 1, 2018~~ (Passed)

Paper and Workshop Decision:
Notification:
Mid-July 2018

Accepted Papers Due:
September 20, 2018

https://cdc2018.ieeecss.org

American Control Conference

JULY 10-12, 2019

PHILADELPHIA, PENNSYLVANIA, USA

ACC 2019

Manuscript Submission:
September 17, 2018

Acceptance/Rejection Notice:
January 31, 2019

Final Manuscript Submission:
March 15, 2019

http://acc2019.a2c2.org/

Conference on Control Technology and Applications

CCTA 2019

August 19–21, 2019

Hong Kong, China