# BERK ALTIN

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## RESEARCH INTERESTS

Advanced control for reliable autonomy of cyber-physical systems using hybrid systems theory, computational and predictive control, and iterative learning control. Applications in power electronics and energy systems, robotics and locomotion, networks, and additive manufacturing. Secondary interests in multidimensional systems, and robust and adaptive control.

## CURRENT POSITION

UNIVERSITY OF CALIFORNIA, Santa Cruz, California                                        2016-present
Hybrid Systems Laboratory, Department of Electrical and Computer Engineering
Postdoctoral Researcher. Working on "Computationally aware cyber-physical systems". Developing model predictive control strategies hybrid dynamical systems for optimal performance under hardware limitations and hard safety constraints. Advised by Ricardo G. Sanfelice.

## EDUCATION

UNIVERSITY OF MICHIGAN, Ann Arbor, Michigan                                            2011-2016
Ph.D. in Electrical Engineering: Systems
Dissertation: Relaxing Fundamental Assumptions in Iterative Learning Control
Doctoral Committee: Kira L. Barton and Jessy W. Grizzle (co-chairs), James S. Freudenberg, A. Galip Ulsoy

UNIVERSITY OF MICHIGAN, Ann Arbor, Michigan                                            2013-2016
M.S. in Mathematics

UNIVERSITY OF MICHIGAN, Ann Arbor, Michigan                                            2011-2013
M.S. in Electrical Engineering: Systems

SABANCI UNIVERSITY, Istanbul, Turkey                                                  2007-2011
B.S. in Mechatronics Engineering, with Minor Honors in Mathematics

## AWARDS AND HONORS

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| Finalist for the Best Conference Paper Award with "Set-Based Predictive Control for Collision Detection and Evasion", 15th IEEE Conference on Automation Science and Engineering. | 2019 |
| Rackham International Conference Travel Grant, University of Michigan. | 2015 |
| Rackham Conference Travel Grant, University of Michigan. | 2014 |
| Student Travel Award, IEEE. | 2013 |
| Fulbright Fellowship, Institute of International Education. | 2012-2014 |
| Dilek Sabancı Merit Scholarship, Sabancı University. One of five awarded among all junior students. | 2009-2011 |
| Sakıp Sabancı Merit Scholarship, Sabancı University. One of eighty-one awarded among all students of the university. | 2008-2009 |
| Merit Scholarship, Sabancı University. Awarded for placing in the top 0.1% in the national university entrance exam, among over 1.6 million students. | 2007-2008 |
| Merit Scholarship, Turkish Association of Loans and Housing for Higher Education. Awarded for placing 25th in the national foreign languages examination. | 2007-2011 |

# RESEARCH EXPERIENCE

UNIVERSITY OF CALIFORNIA, Santa Cruz, California                              August 2016-Present
Hybrid Systems Laboratory, Department of Electrical and Computer Engineering
Working on "Computationally aware cyber-physical systems" as a postdoctoral researcher. Developing model predictive control strategies hybrid dynamical systems for optimal performance under intermittent measurements, computational delays, and hard safety constraints. Advised by Ricardo G. Sanfelice.

UNIVERSITY OF MICHIGAN, Ann Arbor, Michigan                                  May 2012-June 2016
Barton Research Group, Department of Mechanical Engineering
Worked on "Robust iterative learning control" and "High fidelity additive manufacturing at the micro-scale" as a graduate student research assistant. Worked on "Strategic in-theater modularization and communalization" as a graduate student research assistant. Unified iterative learning and $\mathcal{L}_1$ adaptive control paradigms for high-precision motion control, collected data for optimization studies. Developed sensing methods to model and control the electrohydrodynamic jet printing process. Developed mathematical tools to control material deposition and assess stability for additive manufacturing systems via the repetitive process paradigm. Advised by Kira L. Barton.

UNIVERSITY OF MICHIGAN, Ann Arbor, Michigan                                  Oct. 2011-Aug. 2012
Human Biomechanics and Control Laboratory, Department of Mechanical Engineering
Worked on "Perceived effort reward framework—an optimization-based rehabilitation methodology" as a research assistant. Debugged the embedded software and implemented new algorithms. Improved the LCD-based GUI. Made mechanical and electrical hardware modifications. Processed and analyzed data files, ran studies. Advised by Arthur D. Kuo.

SABANCI UNIVERSITY, Istanbul, Turkey                                         Nov. 2010-Apr. 2011
Microsystems Laboratory, Faculty of Engineering and Natural Sciences
Worked on "Force observer-based bilateral control in micromanipulation" as an undergraduate research assistant (graduation project). Researched optimal control, vibration control methods, cell injection techniques and piezo actuator models. Advised by Asif Šabanović.

HUNGARIAN ACADEMY OF SCIENCES, Budapest, Hungary                             July-Aug. 2010
Cognitive Informatics Research Group, Systems and Control Laboratory, Institute for Computer Science and Control
Worked on "Contrast vision-based grasp force feedback in telemanipulation" as an intern. Studied contrast sensitivity model of the human eye and applications of sensory substitution. Implemented new stimulus forms for visual feedback, introduced a test log class for experimental data acquisition, implemented feedback mode and parameter functionality to the software environment. Advised by Péter Korondi.

SABANCI UNIVERSITY, Istanbul, Turkey                                         Apr.-June 2010
Microsystems Laboratory, Faculty of Engineering and Natural Sciences
Worked on "Design and realization of a workstation for laser micromachining" as an undergraduate research assistant. Modeled and simulated a 2-axis preview-controlled micro motion mechanism; helped in the implementation of the preview controller for constant velocity trajectory tracking using time-based spline approximation; helped in the implementation of a novel estimator for disturbance rejection. Advised by Asif Šabanović.

# FUNDED RESEARCH

Postdoctoral researcher, "CPS: Synergy: Collaborative Research: Computationally Aware Cyber-          2016-present
Physical Systems", sponsored by NSF (CNS-1544396). Project PI: Ricardo G. Sanfelice.
Graduate researcher, "High Fidelity Additive Manufacturing at the Micro-scale", sponsored by NSF          2013-2016
(CMMI-1334204). Project PI: Kira L. Barton.
Graduate researcher,"Strategic in-Theater Modularization and Commonalization of Advanced Vehicle          2013
System", sponsored by the Automotive Research Center and TARDEC. Project PI: Panos Y. Papalambros.

## RESEARCH ADVISING

Master's Thesis Committee Member: Brendan E. Short, "A Hybrid Systems Approach to Tracking Con-  Dec. 2018
trol for a Fully Actuated Walking Bipedal Robot"; University of California, Santa Cruz
Master's Thesis Committee Member: Daniel T. Lavell, "A Hybrid PID Design for Asymptotic Stabiliza-  Mar. 2018
tion with Intermittent Measurements"; University of California, Santa Cruz

## TEACHING EXPERIENCE

Guest Lecturer. CMPE 241, Introduction to Feedback Control Systems; University of California, Santa  Fall 2017
Cruz
Guest Lecturer. CMPE 8, Robot Automation: Intelligence through Feedback Control; University of Cali-  Fall 2017
fornia, Santa Cruz

## PROFESSIONAL SERVICE AND MEMBERSHIPS

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|---|---|
| Member, SIAM; Control and Systems Theory Group | 2015-Present |
| Member, IEEE; Control Systems Society, Hybrid Systems Technical Committee Member | 2013-Present |

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| Co-organizer of the workshop "Model Predictive Control of Hybrid Dynamical Systems", IFAC World Congress | 2020 |
| Co-organizer of the workshop "Model Predictive Control of Hybrid Dynamical Systems", IEEE Conference on Decision and Control | 2020 |
| Associate Editor, European Control Conference | 2020 |
| Co-Chair of the session "Hybrid and Cyber-Physical Systems", American Control Conference | 2019 |
| Best Student Paper Award Committee Member, American Control Conference | 2019 |
| Chair of the session "Stability of Hybrid Systems", American Control Conference | 2018 |
| Chair of the session "Control, Dynamics, and Robotics", University of Michigan Engineering Graduate Symposium | 2015 |

*Journal Reviewer*: Automatica, IEEE Transactions on Automatic Control, IEEE Control Systems Letters, IEEE Transactions on Control Systems Technology, International Journal of Control, International Journal of Robust and Nonlinear Control, International Journal of Adaptive Control and Signal Processing, Asian Journal of Control, Journal of Process Control, Mechatronics, IEEE/ASME Transactions on Mechatronics, IEEE Transactions on Industrial Electronics

*Conference Reviewer*: IEEE Conference on Decision and Control, American Control Conference, IFAC World Congress, European Control Conference, IEEE Conference on Control Technology and Applications (IEEE Multi-Conference on Systems and Control), IFAC Conference on Nonlinear Model Predictive Control, ASME Dynamic Systems and Control Conference, International Symposium on Flexible Automation

# INVITED TALKS

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| Feedback Control Algorithms for High-Confidence Autonomy of Cyber-Physical Systems; Delft University of Technology | Nov. 20, 2019 |
| Feedback Control Algorithms for High-Confidence Autonomy of Cyber-Physical Systems; Eindhoven University of Technology | June 24, 2019 |
| Feedback Control Algorithms for High-Confidence Autonomy of Cyber-Physical Systems; University of California, Riverside | Mar. 6, 2019 |
| Predictive Control of Hybrid Dynamical Systems; University of California, Santa Cruz | Apr. 27, 2018 |
| From Iterative Learning to Multidimensional Systems; University of California, Santa Cruz | Apr. 18, 2016 |
| From Iterative Learning to Multidimensional Systems; Georgia Institute of Technology | Apr. 11, 2016 |
| From Iterative Learning to Multidimensional Systems; Washington University in St. Louis | Mar. 16, 2016 |
| Relaxing Fundamental Assumptions in Iterative Learning Control; Missouri University of Science and Technology | Feb. 16, 2016 |
| Control for Advanced Manufacturing: Linearized Stability of Differential Repetitive Processes; University of Michigan, Ann Arbor | Apr. 4, 2015 |

# PUBLICATIONS

## JOURNAL ARTICLES

[J1]  B. Altın and R. G. Sanfelice. "Hybrid Systems with Delayed Jumps: Asymptotic Stability via Robustness and Lyapunov Conditions". In: *IEEE Transactions on Automatic Control* (2020), to appear.

[J2]  B. Altın, Z. Wang, D. J. Hoelzle, and K. Barton. "Robust Monotonically Convergent Spatial Iterative Learning Control: Interval Systems Analysis via Discrete Fourier Transform". In: *IEEE Transactions on Control Systems Technology* (2018), pp. 1–14.

[J3]  B. Altın and K. Barton. "Rohrs' Example Revisited: On the Robustness of Adaptive Iterative Learning Control". In: *Asian Journal of Control* 20.3 (2018), pp. 993–1002.

[J4]  B. Altın and K. Barton. "Exponential stability of nonlinear differential repetitive processes with applications to iterative learning control". In: *Automatica* 81 (2017), pp. 369 –376.

[J5]  B. Altın, J. Willems, T. Oomen, and K. Barton. "Iterative Learning Control of Iteration-Varying Systems via Robust Update Laws with Experimental Implementation". In: *Control Engineering Practice* 62 (2017), pp. 36 –45.

[J6]  K. D'Souza, A. E. Bayrak, N. Kang, H. Wang, B. Altın, K. Barton, J. Hu, P. Papalambros, B. I. Epureanu, and R. Gerth. "An integrated design approach for evaluating the effectiveness and cost of a fleet". In: *The Journal of Defense Modeling and Simulation: Applications, Methodology, Technology* 13.4 (2016), pp. 381–397.

[J7]  B. Altın and K. Barton. "Robust iterative learning for high precision motion control through $\mathcal{L}_1$ adaptive feedback". In: *Mechatronics* 24.6 (2014). Control of High-Precision Motion Systems, pp. 549 –561.

## CONFERENCE PAPERS

[C8]  B. Altın and R. G. Sanfelice. "Model Predictive Control for Hybrid Dynamical Systems: Sufficient Conditions for Asymptotic Stability with Persistent Flows or Jumps". In: *American Control Conference (ACC), 2020*. July 2020.

[C9]  B. Altın and R. G. Sanfelice. "Regularity Properties and Continuous Approximations of Reachable Set Mappings for Nominally Well-Posed Hybrid Systems". In: *Decision and Control (CDC), 2020 IEEE 59th Annual Conference on*. Dec. 2020, to appear.

[C10]  M. Maghenem, B. Altın, and R. G. Sanfelice. "Regularity Properties of Reachability Maps for Hybrid Dynamical Systems with Applications to Safety". In: *American Control Conference (ACC), 2020*. July 2020.

[C11]  B. Altın and R. G. Sanfelice. "Asymptotically Stabilizing Model Predictive Control for Hybrid Dynamical Systems". In: *2019 American Control Conference (ACC)*. 2019, pp. 3630–3635.

[C12]  J. Crowley, Y. Zeleke, B. Altın, and R. G. Sanfelice. "Set-Based Predictive Control for Collision Detection and Evasion". In: *Automation Science and Engineering (CASE), 2019 IEEE 15th International Conference on*. 2019, pp. 541–546.

[C13] P. Ojaghi, B. Altın, and R. G. Sanfelice. "A Model Predictive Control Framework for Asymptotic Stabilization of Discretized Hybrid Dynamical Systems". In: *Decision and Control (CDC), 2019 IEEE 58th Annual Conference on*. 2019, pp. 2356–2361.

[C14] B. Altın and R. G. Sanfelice. "Model Predictive Control under Intermittent Measurements due to Computational Constraints: Feasibility, Stability, and Robustness". In: *2018 Annual American Control Conference (ACC)*. June 2018, pp. 1418–1423.

[C15] B. Altın and R. G. Sanfelice. "On Robustness of Pre-Asymptotic Stability to Delayed Jumps in Hybrid Systems". In: *2018 Annual American Control Conference (ACC)*. June 2018, pp. 2204–2209.

[C16] B. Altın, P. Ojaghi, and R. G. Sanfelice. "A Model Predictive Control Framework for Hybrid Dynamical System". In: *6th IFAC Conference on Nonlinear Model Predictive Control NMPC 2018*. Aug. 2018, pp. 128 –133.

[C17] B. Altın and K. Barton. "Learning Control of Linear Iteration Varying Systems with Varying References through Robust Invariant Update Laws". In: *American Control Conference (ACC), 2015*. June 2015, pp. 4880–4885.

[C18] B. Altın and K. Barton. "On linearized stability of differential repetitive processes and iterative learning control". In: *Decision and Control (CDC), 2015 IEEE 54th Annual Conference on*. Dec. 2015, pp. 6064–6069.

[C19] B. Altın, L. Y. L. Tse, and K. Barton. "Visual Feedback Based Droplet Size Regulation in Electrohydrodynamic Jet Printing". In: *ASME 2014 Dynamic Systems and Control Conference*. Oct. 2014.

[C20] B. Altın and K. Barton. "$\mathcal{L}_1$ Adaptive Control in an Iterative Learning Control Framework for Precision Nanopositioning". In: *ASPE Spring Topical Meeting, 2013*. Vol. 55. Apr. 2013, pp. 88–93.

[C21] B. Altın and K. Barton. "$\mathcal{L}_1$ Adaptive Control in an Iterative Learning Control Framework: Stability, Robustness and Design Trade-offs". In: *American Control Conference (ACC), 2013*. June 2013, pp. 6697–6702.

WORKS IN PROGRESS

[W22] B. Altın and R. G. Sanfelice. *Existence of Solutions and Consistent Approximations to Hybrid Optimal Control Problems*.

[W23] B. Altın and R. G. Sanfelice. *Predictive Control of Hybrid Dynamical Systems*.

[W24] B. Altın and R. G. Sanfelice. *Regularity Properties and Computation of Reachable Sets of Hybrid Dynamical Systems*.

[W25] B. Altın and R. G. Sanfelice. *Robustness of Model Predictive Control to Computational Limitations*.

[W26] P. Ojaghi, B. Altın, and R. G. Sanfelice. *A Model Predictive Control Framework for Hybrid Dynamical Systems with Discretized Flows*.

[W27] N. Risso, B. Altın, J. Sprinkle, and R. G. Sanfelice. *Set-Valued Model Predictive Control*.

## POSTER PRESENTATIONS

Computationally Aware Cyber-Physical Systems; NSF Cyber-Physical Systems Principal Investigators Meeting, Alexandria, VA — Nov. 15, 2018

Computationally Aware Cyber-Physical Systems; Bay Area Robotics Symposium, University of California, Berkeley — Nov. 17, 2017

Computationally Aware Cyber-Physical Systems; NSF Cyber-Physical Systems Principal Investigators Meeting, Alexandria, VA — Nov. 13, 2017

Computationally Aware Cyber-Physical Systems; Symposium on Robot Learning, University of California, Berkeley — May 1, 2017

Robust Iterative Learning for High Precision Control through $\mathcal{L}_1$ Adaptive Feedback; University of Michigan Engineering Graduate Symposium, University of Michigan, Ann Arbor — Nov. 15, 2013

## LANGUAGES

Turkish (Native), English (Advanced), French (Intermediate)

# References

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