

# Burak Demirel

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## Research Interests

Cyber-physical systems; (wireless) networked control systems; control of mechatronic systems; convex optimization; stochastic control systems; optimal and robust control; time-delayed systems; hybrid/switched systems.

## Education

- May 2015      Ph.D. Automatic Control, KTH Royal Institute of Technology, Stockholm  
Thesis title: *Architectures and Performance Analysis of Wireless Control Systems*  
Thesis advisor: Prof. Mikael Johansson  
Opponent: Prof. Tamer Başar  
Committee: Prof. Ming Cao; Prof. Luca Schenato; Prof. Anders Ahlens
- May 2013      Licentiate of Engineering, KTH Royal Institute of Technology, Stockholm  
Thesis title: *Design and Performance Analysis of Wireless Networked Control Systems*  
Thesis advisor: Prof. Mikael Johansson  
Examiner: Prof. Luca Schenato
- 2009          M.Sc. Mechatronics Engineering, Istanbul Technical University  
Thesis title: *Interactive Computer-Aided Controller Design for Mechatronic Systems*  
Thesis advisor: Prof. Levent Güvenç
- 2009          B.Sc. Control Engineering, Istanbul Technical University (with high honors)
- 2007          B.Sc. Mechanical Engineering, Istanbul Technical University (with summa cum laude)

## Professional Experience

### Academic Experience

- Oct '15 - Present      **Postdoctoral Researcher, Faculty of Electrical Engineering and Information Technology (EIM-E), University of Paderborn, Germany**  
In addition to scientific research, position includes opportunities for teaching, advising students, and writing grants.
- May '15 - Oct '15      **Postdoctoral Researcher, Department of Automatic Control, School of Electrical Engineering and ACCESS Linnaeus Center, KTH Royal Institute of Technology, Sweden**  
In addition to scientific research, position includes opportunities for teaching, advising students, and writing grants.
- Jan '14 – Apr '14      **Visiting Researcher, Electrical Engineering Department, University of Notre Dame**  
I visited Prof. Vijay Gupta's lab at the Electrical Engineering Department at University of Notre Dame. We worked on many research problems including event-triggered control systems, scheduling of charging/decharging of electrical vehicles, and dynamic pricing in electricity markets.
- Apr '11 – May '11      **Visiting Researcher, The Center for Hybrid and Embedded Software Systems, University of California Berkeley**  
I visited Prof. Mikael Johansson (my supervisor who was on sabbatical), Prof. Claire

Tomlin, and Prof. Shankar Sastry at U.C. Berkeley. I presented my research on co-design of controllers and transmission schedules.

July '06 – Oct '09 **Research Assistant, Mechatronics Research Laboratories, Istanbul Technical University**  
I worked on several research topics including the development of repetitive control algorithms for position control of atomic force microscope, construction of a ESP test rig, hardware-in-the-loop simulation of ABS, TCS and ESP. Furthermore, I designed a quarter-car test rig to develop different kinds of controllers and to test sensors (e.g., acceleration sensors and linear encoders).

### Industry Experience

July '06 – Aug '06 **Kale Altinay Robotics A.S. – Gebze, Turkey**  
*Internship in the Mechanical Design Department*  
Designing a conveyor to carry the hood of a vehicle for Tofas Fiat A.S.

July '05 – Aug '05 **HSK A.S. – Istanbul, Turkey**  
*Internship in the Mechanical Design Department*  
Software design to compute strains and forces on materials after welding process.

### Teaching Experience

#### Lecturer, University of Paderborn, Germany

Spring 2015 **L.048.27024 – Advanced Control Methods for Mechatronics**  
*This course focuses on advanced design for closed-loop linear control systems under model uncertainty and exogenous disturbances. In the course, both continuous- and discrete-time analysis and design techniques are treated. Topics include parametric robust control, optimal control, repetitive control and iterative learning algorithms. Mechatronic applications, including vehicle control systems, high-precision tracking systems, and atomic force microscope, will be considered. Students complement analytical treatment with exercises using MATLAB and Simulink.*

#### Co-lecturer and Teaching Assistant, University of Paderborn, Germany

Fall 2015 **L.048.90703 – Advanced Control (Main Lecturer: Prof. Daniel E. Quevedo)**  
*This course focuses on the design of discrete-time control systems, using transfer function and state-space methods. The course is primarily intended to serve engineering students, yet can also be useful to students in physics and other natural sciences.*

#### Teaching Assistant, KTH Royal Institute of Technology, Stockholm, Sweden

Spring 2012, 2013 **EL2450 – Hybrid and Embedded Control Systems (Lecturer: Prof. Dimos Dimarogonas)**  
*Hybrid and Embedded Control Systems is a course on analysis, design and implementation of control algorithms in networked embedded systems. Sensor, actuator and computer nodes are connected over a communication network in such control systems, which are found in emerging applications in automotive engineering, consumer electronics, industrial control, mobile communication, power systems, smart buildings, transportation system etc.*

Spring 2011–2013 **E1 Project Course (Course responsible: Prof. Cristian Rojas)**  
*In this course, the first year students build and control a Segway-like vehicle in LEGO Mindstorms.*

Fall 2010 **EL1000 – Automatic Control (Lecturer: Prof. Bo Wahlberg)**  
*An introductory course on control systems. It provides the students with the basic engineering knowledge of dynamic systems and feedback.*

## Mentoring Experience

- Spring 2010 Volkan Urgan (co-supervised with Prof. Mikael Johansson, Master Thesis), Master of Science Thesis, Networked PID Controllers for Wireless Systems, KTH Royal Institute of Technology, Stockholm.
- Summer 2015 Ylva Steffner and Ciwan Ceylan (co-supervised with Arda Aytekin and Prof. Mikael Johansson), ACCESS Summer Project on **Learning in Control**, KTH Royal Institute of Technology, Stockholm.

## Awards – Scholarships

- 2007 National Scholarship Programme supported by the Scientific and Technical Research Council of Turkey for Master of Science Students
- 2007 Graduation with summa cum laude, Istanbul Technical University, Turkey
- 2006 Honored with Silver Medal in Formula G'06 Solar Car Race organized by the Scientific and Technical Research Council of Turkey as a member of team ARIBA
- 2003–2007 High Honor List (for all semesters)

## Professional Activities (as a guest editor)

- Journals** IET Control Theory & Applications, Special Issue on Resource-efficient Control in Cyber-Physical Systems.

## Professional Activities (as a reviewer)

- Journals** IEEE Transactions on Automatic Control; Automatica, IEEE Transactions on Control Systems Technology; IEEE Transactions on Control of Network Systems; International Journal of Robust and Nonlinear Control; IET Control Theory & Applications.
- Conferences** IEEE Conference on Decision and Control (CDC); American Control Conference (ACC); European Control Conference (ECC); International Federation of Automatic Control (IFAC); IEEE Multi-conference on Systems and Control.

## Professional Memberships

- 2014 – Present Member of the Society for Industrial and Applied Mathematics (SIAM)
- 2008 – Present Member of the American Society of Mechanical Engineers (ASME)
- 2007 – Present Member of the Institute of Electrical and Electronics Engineers (IEEE)

## Computer Skills

- Modeling:** MATLAB/Simulink; Mathematica
- Programming:** C++
- DSPACE Systems:** ds1103 general purpose; ds1005 – ds2210 compact simulator for engine electronic control unit test and diagnosis
- CAD:** Unigraphics NX; SolidWorks; AutoCad

## Grants and External Funding

- 2016 – Present Deutsche Forschungsgemeinschaft (DFG), Priority Programme Cyber-Physical Networking (SPP 1914)  
NICCI: Networked Informed Control – Control Informed Network  
PI: Prof. Holger Karl, Prof. Rolf Findeisen, and Daniel E. Quevedo

## Invited Talks

- [IT5] *On the Trade-Off Between Control and Communication Cost in Wireless Control Systems*. Uppsala University, Uppsala, Sweden, July 2015.
- [IT4] *On the Trade-Off Between Control Performance and Communication Cost in Event-Triggered Control*. University of Notre Dame, South Bend, IN, USA, January 2014.
- [IT3] *Modular Design of Jointly Optimal Controllers and Forwarding Policies for Wireless Control*. Mechatronic Research Laboratories, Okan University, Istanbul, Turkey, December 2011.
- [IT2] *Towards Optimal Co-design of Controllers and Transmission Schedules in WirelessHART*. The Center for Hybrid and Embedded Software Systems, University of California Berkeley, CA, USA, April 2011.
- [IT1] *Parameter Space Design of Repetitive Controllers for Satisfying a Mixed Sensitivity Performance Requirement*. Automatic Control Laboratory, ETH Zürich, Zürich, Switzerland, January 2009.

## Publications

### Submitted Works

- [S2] B. Demirel, H. R. Feyzmahdavian, D. E. Quevedo and M. Johansson, “Optimal control of linear systems with limited control actions: threshold-based event-triggered control”, *Submitted to IEEE Transactions on Automatic Control*, 2016.
- [S1] B. Demirel, V. Gupta, D. E. Quevedo and M. Johansson, “On the Trade-Off Between Control Performance and Communication Cost in Event-Triggered Control”, *Submitted to IEEE Transactions on Automatic Control*, 2014.

### Books

- [B1] B. A. Güvenç, L. Güvenç, B. Demirel and M. T. Emirler, *Control of Mechatronic Systems*, signed book contract with IET Books, and will be delivered till September 2016.

### Theses

- [T3] B. Demirel, “Architectures and Performance Analysis of Wireless Control Systems”, Doctoral Thesis, KTH Royal Institute of Technology, Stockholm, Sweden, May 2015. ISBN 978-91-7595-528-5.
- [T2] B. Demirel, “Design and Performance Analysis of Wireless Networked Control Systems”, Licentiate Thesis, KTH Royal Institute of Technology, Stockholm, Sweden, May 2013. ISBN 978-91-7501-748-8.
- [T1] B. Demirel, “Interactive computer-aided controller design for mechatronic systems, Master of Science Thesis, Istanbul Technical University, Istanbul, Turkey, September 2009.

### Book Chapters

- [BC2] B. Demirel (Student Contributor) “Partially Compliant Force-Generator Mechanism”, Handbook of Compliant Mechanisms by L. L. Howell, S. P. Magleby and B. M. Olsen, Wiley, Feb. 2013.
- [BC1] B. Aksun Güvenç, S. Necipoglu, B. Demirel and L. Güvenç, “Robust Control of Atomic Force Microscopy”, Mechatronics by J. Paulo Davim, Wiley-ISTE, March 2011.

### Journal Papers

- [J4] B. Demirel, Z. Zou, P. Soldati and M. Johansson, “Modular Design of Jointly Optimal Controllers and Forwarding Policies for Wireless Control”, *IEEE Transactions on Automatic Control, Special Issue on Control of Cyber-Physical Systems*, vol. 59, no. 12, pp. 3252 - 3265, Dec. 2014.
- [J3] B. Demirel, C. Briat and M. Johansson, “Deterministic and Stochastic Approaches to Supervisory Control Design for Networked Systems with Time-varying Communication Delays”, *Special Issue*

on the *IFAC ADHS 2012 Conference* in *Nonlinear Analysis: Hybrid Systems*, vol. 10, pp. 94 - 110, 2013.

- [J2] B. Demirel, M. T. Emirler, U. Sönmez and A. Yörükoglu, "Semi-compliant Force Generator Mechanism Design for a Required Impact and Contact Forces", *ASME Journal of Mechanisms and Robotics*, vol. 2, no. 4, Nov. 2010.
- [J1] B. Demirel and L. Güvenç, "Parameter Space Design of Repetitive Controllers for Satisfying a Robust Performance Requirement", *IEEE Transactions on Automatic Control*, vol. 55, no. 8, pp. 1893 - 1899, Aug. 2010.

#### Conference Papers

- [C10] B. Demirel, V. Gupta, D. E. Quevedo and M. Johansson, "Threshold Optimization of Event-Triggered Multi-Loop Control Systems", *Proceedings of the 13<sup>th</sup> International Workshop on Discrete Event Systems (WODES'16)*, Xi'an, China, May 30 - June 1, 2016.
- [C9] B. Demirel, H. R. Feyzmahdavian, E. Ghadimi and M. Johansson, "Stability Analysis of Discrete-Time Linear Systems with Unbounded Stochastic Delays", *Proceedings of the 5<sup>th</sup> IFAC Workshop on Distributed Estimation and Control in Networked Systems (NECSYS'15)*, Philadelphia, Pennsylvania, September 10-11, 2015.
- [C8] B. Demirel, A. Aytakin, D. E. Quevedo and M. Johansson, "To Wait or To Drop: On the Optimal Number of Re-transmissions in Wireless Control", *Proceedings of the European Control Conference (ECC'15)*, Linz, Austria, July 15-17, 2015.
- [C7] B. Demirel, V. Gupta and M. Johansson, "On the Trade-Off Between Control Performance and Communication Cost for Event-Triggered Control over Lossy Networks", *Proceedings of the Biannual European Control Conference (ECC'13)*, Zurich, Switzerland, July 17-19, 2013.
- [C6] Z. Zou, B. Demirel and M. Johansson, "Minimum-Energy Packet Forwarding Policies for LQG Performance in Wireless Control Systems", *Proceedings of the 51<sup>st</sup> IEEE Conference on Decision and Control (CDC'12)*, Maui, Hawaii, Dec. 2012.
- [C5] B. Demirel, C. Briat and M. Johansson, "Supervisory Control Design for Networked Systems with Time-Varying Communication Delays", *Proceedings of the 4<sup>th</sup> IFAC Conference on Analysis and Design of Hybrid Systems (ADHS'12)*, Eindhoven, the Netherlands, June 2012.
- [C4] B. Demirel, Z. Zou, P. Soldati and M. Johansson, "Modular Co-design of Controllers and Transmission Schedules in WirelessHART", *Proceedings of the 50<sup>th</sup> IEEE Conference on Decision and Control and European Control Conference (CDC'11)*, Orlando, FL, USA, Dec. 2011.
- [C3] B. Demirel and L. Güvenç, "Control of Mechatronics Systems - COMES Toolbox", *Proceedings of the ASME Biennial Conference on Engineering Systems Design and Analysis*, Istanbul, Turkey, July 12 - 14, 2010.
- [C2] S. Necipoglu, B. Demirel and L. Güvenç, "Fast AFM Scanning with Parameter Space Based Robust Repetitive Control Designed Using COMES Toolbox", *Proceedings of the ASME Biennial Conference on Engineering Systems Design and Analysis*, Istanbul, Turkey, July 12 - 14, 2010.
- [C1] B. Demirel, M.T. Emirler, A. Yörükoglu, N. Koca and U. Sönmez, "Compliant Impact Generator for Required Impact and Contact Force", *Proceedings of the ASME International Mechanical Engineering Congress and Exposition (IMECE'08)*, Boston, MA, October 31 - November 06, 2008.

## Referees

### Prof. Mikael Johansson

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### Prof. Daniel E. Quevedo

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### Prof. Levent Güvenc

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### Prof. Vijay Gupta

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