Cagdas Denizel Onal

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ACADEMIC BACKGROUND

Postdoctoral Associate
2009 - Present

Massachusetts Institute of Technology, Cambridge, MA, USA
Computer Science and Artificial Intelligence Laboratory

- Research: *Flexible robotic systems.*
- Supervisor: Professor Daniela Rus
- Highlights: Soft robotics, printable robotics, fluidic elastomer actuators, chemical pressure generation, electropermanent magnet valves, bio-inspiration, iterative learning control, shape memory alloy actuators, characterization, image processing.

Ph.D.
January 2009

Carnegie Mellon University, Pittsburgh, PA, USA
Department of Mechanical Engineering - Nanorobotics Laboratory

- GPA: 4.00 / 4.00
- Dissertation: *Atomic Force Microscope based Automated and Teleoperated Mechanical Micro/ Nano-manipulation.*
- Advisor: Professor Metin Sitti
- Highlights: Atomic force microscopy, micro/nano-robotics, automation, bilateral control, adaptive control, passivity control, observer design, characterization, micro/nano-mechanics, image processing, visual servoing.

M.Sc.
June 2005

Sabanci University, Istanbul, Turkey
Electrical Engineering and Computer Science - Mechatronics Program

- GPA : 3.78 / 4.00
- Thesis: *Bilateral Control – A Sliding Mode Control Approach.*
- Advisor: Professor Asif Sabanovic
- Highlights: Bilateral control, sliding mode control, force control, constrained/free motion control, hybrid force/position control, decentralized control, model reference control, piezoelectric actuators.

B.Sc.
June 2003

Sabanci University, Istanbul, Turkey
Electrical Engineering and Computer Science - Mechatronics Program

- GPA: 3.67 / 4.00
- Graduation Project: *Vision Based Control and Obstacle Avoidance of a Mobile Robot.*
- Advisor: Professor Asif Sabanovic
- Highlights: Engineering electrical/mechanical design, embedded control, mobile robotics, image processing, visual servoing.

AWARDS

January 2007	Best Mechanical Engineering Ph.D. Qualifying Examination Performance
February 2004	Dean's Letter of Appreciation for T.A. Performance
June 2003	Second rank, Class of 2003. Mechatronics Engineering Program, Sabanci University
1999 - 2003	Merit Scholarship

RESEARCH INTERESTS

Robotics	Soft robotics • Printable robotics • Novel actuators, sensors, and mechanisms • Energy generation • Bio-inspired robotics • Image processing • Machine vision
Control Theory	Nonlinear control • Embedded control • Teleoperation (bilateral control) • Sliding mode control • Iterative learning control
Nano-Robotics	Scanning probe microscopy • Micro/nano-scale physics • Micro/nano-fabrication and assembly

RESEARCH EXPERIENCE

Postdoctoral Associate
2009 – Present

Massachusetts Institute of Technology, Cambridge, MA, USA

Soft Robotics
- Inherent safety and adaptability of a soft material, human interaction, rough terrain negotiation.
- Fluidic actuation of embedded channels to directly induce stresses in the elastomer.
- Pneumatic battery: on-board pressure generation using chemistry, self-regulated gas generation, silent operation, no electrical energy.
- Electropermanent magnet ball valves: Energy-efficient compact valves, embeddable in an elastomer.
- A family of fluidic robots: Modular composition, embedded sensors, actuators, valves, and control electronics.

Printable Robotics
- Planar fabrication techniques to make functional 3-D devices.
    High speed, low cost using laser engraving or microfabrication techniques.
- Origami crease patterns to transform into 3-D by folding.
    A set of functional folds, as components of a robotic body.
- Shape memory coil actuation.
    Compact, high energy density, distributed actuation.
- Printable electronics.
    Custom flexible circuit boards embedded on the robot body.

Ph.D.
2005 – 2009

Carnegie Mellon University, Pittsburgh, PA, USA

Stick-Slip Fibrillar Linear Actuator
- Utilizing asymmetrical frictional properties of angled Gecko micro-fiber arrays.
- High force, high displacement range from an oscillating high-force, low-displacement piezoelectric actuator.

Automated 2-D Micro/Nano-Particle Manipulation and Assembly
- An atomic force microscope (AFM) tip as the end-effector.
- Visual feedback for microparticles, force feedback for nanoparticles.
    First closed-loop manipulation of nanoparticles.

Teleoperated 3-D Force Feedback from the Micro/Nano-Scale
- A scaled bilateral controller.
    Transparency, impedance reflection and stability issues taken into account.
- Augmented virtual reality interface to compliment force feedback.
    First general experimental 3-D force feedback from the nanoscale.

| M.Sc. 2003 - 2005 | **Sabanci University**, Istanbul, Turkey |

Bilateral Control - A Sliding Mode Control Approach
- A reflex mechanism on the remote side.
  Inspired by the human nervous system, to react to forces quickly before they are fed back to operator.
  A force/position hybrid controller to seamlessly switch between constrained/free motions.
- A decentralized architecture as another approach.
  Applicable to cooperation/coordination of multiple sub-systems.

TEACHING EXPERIENCE

| Teaching Staff Spring 2011 | **Massachusetts Institute of Technology**, Cambridge, MA, USA |

Robotics: Science and Systems
- Sophomore level (50 students)
- Prepared and held lectures

| Teaching Assistant Spring 2007 | **Carnegie Mellon University**, Pittsburgh, PA, USA |

Stress Analysis
- Sophomore level (100 students)
- Held weekly office hours, conducted weekly recitation sessions, and proctored exams.

Spring 2006 Computer Aided Engineering
- Graduate level (35 students)
- Prepared weekly homework solutions. Held weekly office hours and homework problem solving sessions. Proctored exams.

HONORS

2003 - 2005	Officer – Sabanci University Graduate Student Association (SUMED)
2003 - 2005	Argentinean Tango Performer
2001 - 2002	Volunteer Teacher – Education Volunteers of Turkey (TEGV)
	Founding Member of Sabanci University IEEE Student Branch
Technical Reviewer	IEEE Transactions on Robotics • IEEE Transactions on Nanotechnology • Sensors Journal • Journal of Micromechanics & Microeng. • IEEE Transactions on Mechatronics • Journal of Micro-Nano Mechatronics • IEEE Transactions on Industrial Electronics • ASME Dynamic Systems Meas. & Control • IEEE Transactions on Control Systems Tech. • IEEE Int. Conf. on Robotics & Automation • IEEE/RSJ Int. Conf. on Intel. Rob. and Sys. • IEEE Conf. on Automation Sci. and Eng. • IEEE/ASME Conf. on Adv. Intel. Mechat.

SKILLS & ABILITIES

Programming	C/C++ • OpenGL • OpenCV • PERL • AutoIt
Software and Tools	MATLAB • Simulink • Solidworks • ANSYS • Microsoft Visual Studio • Altium Designer • AVR Studio • Arduino
Operating Systems	Windows 95/98/2000/XP/7 • (RTAI) Linux • Unix
Languages	Advanced English • Basic German • Native speaker of Turkish

PUBLICATIONS

Books

[1] H. Xie, **C. D. Onal**, S. Regnier, and M. Sitti, *Atomic Force Microscopy based Nanorobotics*, Springer Tracts in Advanced Robotics (STAR) series, 71, 2011.

Book Chapters

[2] **C. D. Onal**, O. Ozcan, and M. Sitti, "Automated Tip based 2-D Mechanical Assembly of Micro/Nanoparticles," *In Feedback Control of MEMS to Atoms*, 2011.

[3] **C. D. Onal**, O. Ozcan, and M. Sitti, "Atomic Force Microscopy based Nanomanipulation Systems," *In Handbook of Nanophysics*, 2010.

[4] A. Sabanovic, K. Abidi, and **C. D. Onal**, "Sliding Mode Control Application to Nano Positioners," *In Advances in Variable Structure and Sliding Mode Control Series: Lecture Notes in Control and Information Sciences*, 334, 2006.

Journal Articles

[5] **C. D. Onal**, R. J. Wood, and D. Rus, "An Origami-Inspired Approach to Worm Robots", *IEEE/ASME Transactions on Mechatronics*, 2011. Submitted.

[6] S. Seok, **C. D. Onal**, R. J. Wood, D. Rus, and S. Kim, "Meshworm: A Peristaltic Soft Robot with Antagonistic Nickel Titanium Coil Actuators," *IEEE/ASME Transactions on Mechatronics*, 2011. Submitted.

[7] **C. D. Onal**, O. Ozcan, and M. Sitti, "Automated 2-D Nanoparticle Manipulation using Atomic Force Microscopy," *IEEE Transactions on Nanotechnology*, 2011.

[8] **C. D. Onal** and M. Sitti, "Teleoperated 3-D Force Feedback from the Nanoscale with an Atomic Force Microscope," *IEEE Transactions on Nanotechnology*, Vol. 9, No. 1, pp. 46–54, Jan. 2010.

[9] B. Sumer, **C. D. Onal**, B. Aksak, and M. Sitti, "An Experimental Analysis of Elliptical Adhesive Contact," *Journal of Applied Physics*, Vol. 107, p. 113512, June 2010.

[10] F. Krohs, **C. D. Onal**, M. Sitti, and S. Fatikow, "Towards Automated Nanoassembly with the Atomic Force Microscope: A Versatile Drift Compensation Procedure," *ASME Journal of Dynamic Systems, Measurement, and Control*, Vol. 131, No. 6, p. 061106, November 2009.

[11] **C. D. Onal** and M. Sitti, "A Scaled Bilateral Control System for Experimental One-Dimensional Teleoperated Nanomanipulation," *International Journal of Robotics Research*, Vol. 28, No. 4, pp. 484–497, 2009.

[12] **C. D. Onal**, B. Sumer, and M. Sitti, "Cross-talk Compensation in Atomic Force Microscopy," *Review of Scientific Instruments*, Vol. 79, No. 10 p. 103706, October 2008.

[13] N. A. Lynch, **C. D. Onal**, E. Schuster, and M. Sitti, "Vision-based feedback strategy for controlled pushing of microparticles," *Journal of Micro/Nano-Mechatronics*, Vol. 4, No. 1-2, pp. 73–83, 2008.

[14] **C. D. Onal** and M. Sitti, "Visual Servoing Based Autonomous 2D Manipulation of Microparticles using a Nanoprobe," *IEEE Transactions on Control Systems Technology*, Vol. 15, No. 5, pp. 842–852, 2007.

[15] A. Sabanovic, N. Sabanovic, and **C. D. Onal**, "Sliding Modes in Motion Control Systems," *Automatika*, Vol. 46, No. 1-2, pp. 17–27, 2005.

Conference Proceedings

[16] **C. D. Onal** and D. Rus, "A Modular Approach to Soft Robots," *IEEE International Conference on Robotics and Automation*, 2012. Submitted.

[17] A. D. Marchese, **C. D. Onal**, and D. Rus, "Soft Robot Actuators using Energy-Efficient Valves Controlled by Electropermanent Magnets," *in IEEE/RSJ International Conference on Intelligent Robots and Systems*, Sept 2011.

[18] **C. D. Onal**, X. Chen, G. M. Whitesides, and D. Rus, "Soft Mobile Robots with On-Board Chemical Pressure Generation," *in International Symposium on Robotics Research*, Aug 2011.

[19] **C. D. Onal**, R. J. Wood, and D. Rus, "Towards Printable Robotics: Origami-Inspired Planar Fabrication of Three-Dimensional Mechanisms," *in IEEE International Conference on Robotics and Automation*, Shanghai, China, May 2011.

[20] **C. D. Onal**, B. Sumer, O. Ozcan, A. Nain, and M. Sitti, "Tip based robotic precision micro/nanomanipulation systems," *in Proc. of SPIE* Vol. 8058 80580M-1, April 2011.

[21] N. Corell, **C. D. Onal**, H. Liang, E. Schoenfeld, and D. Rus, "Soft Autonomous Materials - Using Programmed Elasticity and Embedded Distributed Computation," *in International Symposium on Experimental Robotics (ISER)*, New Delhi, India, December 2010.

[22] S. Seok, **C. D. Onal**, R. J. Wood, D. Rus, and S. Kim, "Peristaltic locomotion with antagonistic actuators in soft robotics," *Proc. IEEE International Conference on Robotics and Automation*, pp. 1228–1233, Anchorage, AK, May 2010.

[23] **C. D. Onal**, O. Ozcan, and M. Sitti, "Automated 2-D Nanoparticle Manipulation with an Atomic Force Microscope," *Proc. IEEE International Conference on Robotics and Automation*, pp. 1814–1819, Kobe, Japan, May 2009.

[24] **C. D. Onal**, C. Pawashe, and M. Sitti, "A Scaled Bilateral Control System for Experimental 1-D Teleoperated Nanomanipulation Applications," *Proc. IEEE/RSJ International Conference on Intelligent Robots and Systems*, pp. 483–488, San Diego, CA, October 2007.

[25] N. A. Lynch, **C. D. Onal**, E. Schuster, and M. Sitti, "A Strategy for Vision-Based Controlled Pushing of Microparticles," *Proc. IEEE International Conference on Robotics and Automation*, pp. 1413–1418, Roma, Italy, 2007.

[26] **C. D. Onal** and M. Sitti, "Autonomous 2D Microparticle Manipulation based on Visual Feedback," *Proc. IEEE/ASME International Conf. on Advanced Intelligent Mechatronics*, pp. 1–6, Zurich, Switzerland, 2007.

[27] **C. D. Onal** and A. Sabanovic, "Plant Behaviour Dictation using a Sliding Mode Model Reference Controller," *Proc. International Workshop on Advanced Motion Control (AMC'06)*, pp. 243–248, Istanbul, Turkey, March 2006.

[28] **C. D. Onal** and A. Sabanovic, "Bilateral Control with a Reflex Mechanism on the Slave Side," *Proc. Conference of the IEEE Industrial Electronics Society (IECON'05)*, pp. 195–200, Raleigh, North Carolina, 2005.

[29] **C. D. Onal**, K. Abidi and A. Sabanovic, "A Cascaded Sliding Mode Hybrid Force/Position Controller", *Proc. IEEE Int. Symp. on Industrial Electronics (ISIE'05)*, pp. 183–188, Dubrovnik, Croatia, June 2005.

[30] A. Sabanovic, S. Khan, and **C. D. Onal**, "Hybrid Motion Controller - SMC Point of View", *Proc. IEEE International Symposium on Industrial Electronics (ISIE'05)*, pp. 1483–1488, Dubrovnik, Croatia, June 2005.

[31] A. Sabanovic and **C. D. Onal**, "Hybrid Control - SMC Point of View", *Proc. International Power Electronics Conference (IPEC'05)*, pp. 1815–1822, Singapore, 2005.

Theses

[32] **C. D. Onal**, *Atomic Force Microscope based Automated and Teleoperated Mechanical Micro/Nanomanipulation,* PhD Thesis, Mechanical Engineering, Carnegie Mellon University, January 2009.

[33] **C. D. Onal**, *Bilateral Control: A Sliding Mode Control Approach,* MSc Thesis, Electrical Engineering and Computer Science, Sabanci University, Turkey, July 2005.

Patents

[34] **C. D. Onal**, X. Chen, G. M. Whitesides, and D. Rus, "Self-Regulating Pressure Source", U.S. Patent App. No. 61479529.