## Patrick M. Aubin

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2004 - 2010

Harvard University Wyss Institute for Biologically Inspired Engineering 3 Blackfan Circle Boston, MA 02115

# **Research Interests**

Wearable robotics, biomechanics, cadaveric gait simulation, machine learning, intelligent control systems, neurodegenerative diseases and human sensorimotor control.

## Education

<b>Ph.D. Electrical Engineering, Robotics and Controls</b> Dissertation: "The Robotic Gait Simulator: A Dynamic Foot and Ankle Model for Biomechanics Research." Advisor: William Ledoux, Ph.D.	2010
<b>M.S. Electrical Engineering, Robotics and Controls</b> Advisor: Blake Hannaford, Ph.D.	2006
B.S. Electrical Engineering	2004
Experience	
Postdoctoral Fellow Harvard University, Cambridge, MA, USA Wyss Institute for Biologically Inspired Engineering Developing a soft robotic exosuit for gait assistance. Performing gait analysis to determine the suit's effi injury prevention and metabolic power reduction. Designing a robotic hand exoskeleton system for at-ho and grasp assistance for children with cerebral palsy. Mentoring undergraduate and graduate engineering s	2012 - present ficacy in terms of ome rehabilitation students.
U.S. Fulbright Program Grantee & Whitaker International Scholar Vilnius Gediminas Technical University, Vilnius, Lithuania Departments of Biomechanics and Electronic Systems Investigated novel diagnostic and monitoring methods for Parkinson's disease based on wireless inerti- machine learning classifier. Mentored several M.S. students.	2010 - 2012 ial sensors and a
Research Collaborator Tallinn University of Technology, Tallinn, Estonia Center for Biorobotics	2010 - 2012

Developed surgical phantom models for two FP7 collaborative projects: Intelligent Surgical Robotics (I-SUR) and Patient Safety in Robotic Surgery (SAFROS). Mentored a Mechanical Engineering Ph.D. student.

#### **Research Assistant**

### U.S. Department of Veterans Affairs Hospital, Seattle, WA, USA

### Center of Excellence for Limb Loss Prevention and Prosthetic Engineering

Built a novel robotic cadaveric gait simulator (RGS) capable of recreating gait kinematics, kinetics, and tendon forces *in vitro* for biomechanics research. This machine incorporates a cadaveric lower limb, a six degrees of freedom parallel robot, fuzzy logic ground reaction force control, tendon force control, a real time embedded controller, and a graphical user interface. The RGS was used to simulate transtibial amputee gait, optimize arthrodesis of the first metatarsophalangeal joint, investigate the etiology of the crossover toe deformity of the second metatarsophalangeal joint, model and quantify kinematic changes in flat feet, and quantify foot bone kinematics using a 10 segment *in vitro* foot model.

University of Washington, Seattle, WA, USA Sensors, Energy, and Automation Laboratory (SEAL) Designed and implemented a novel multiplexing circuit for a distributed non-invasive array of fringing electric f used for on-line control of resin transfer molding.	eld sensors
Teaching and Mentoring Experience	
Adjunct Assistant Professor Vilnius Gediminas Technical University, Vilnius, Lithuania College of Mechanical Engineering Taught the undergraduate course Analysis and Design of Control Systems Using MATLAB. Mentored several M.S. students.	2012
Visiting Lecturer Shanghai Normal University, Shanghai, China College of Mechanical and Electronic Engineering Taught two undergraduate courses, Mechatronics and In System Programming. Received highly positive student evaluations.	2007-2008
<b>Teaching Assistant</b> <b>University of Washington, Seattle, WA, USA</b> <b>Department of Electrical Engineering</b> Led the laboratory sessions for the senior capstone robotics and controls course. This electrical engineering class focused on programming a Motorola 6811 microcontroller based mobile robot to perform various sensor intensive tasks.	2004
Software	

2003

MATLAB, LabVIEW, C++, Java, OpenSim

# Scholarships and Awards

**Research Assistant** 

U.S. Department of State Fulbright Grant	2010
Whitaker International Bioengineering Scholar	2010
Best abstract, second place, Northwest Biomechanics symposium	2004
Patricia Lynch Memorial College of Engineering Scholarship	2003

# **Professional Memberships**

Institute of Electrical and Electronics Engineers (IEEE), member since 2003 European Society of Biomechanics, member Lithuanian Society of Biomechanics, member

## Journal Articles

- 1. Aubin, P.M., De Rossi, S. Wehner, M., Stirling, L., Wood, R., and Walsh, C. "A Soft Exosuit to Assist with Locomotion and Reduce Metabolic Power", in preparation, 2013.
- 2. Öpik, R. Aubin, P.M., and Kruusmaa, M. "Haptic Perception of Nonlinear Viscoelastic Materials: A Psychophysics Experiment", *Experimental Brain Research*, submitted, 2013.
- 3. Aubin, P.M., Whittaker, E., and Ledoux, W.R. "A Robotic Cadaveric Gait Simulator with Fuzzy Logic Vertical Ground Reaction Force Control", *IEEE Transactions on Robotics*, 28(1): 246-255, 2012.
- 4. Whittaker, E., Aubin, P.M., and Ledoux, W.R. "Foot Bone Kinematics As Measured In A Cadaveric Robotic Gait Simulator", *Gait & Posture*, 33: 645–650, 2011.
- 5. Jackson, L.T., Aubin, P.M., Cowley, M.S., Sangeorzan, B.J., and Ledoux, W.R. "A Robotic Cadaveric Static Flatfoot Simulation of Stance Phase", *Journal of Biomechanical Engineering*, 133(5): 051005, 2011.
- Weber, J.R., Aubin, P.M., Sangeorzan, B.J., and Ledoux, W.R. "Crossover Toe Deformity of the Second Metatarsophalangeal Joint: A Robotic Cadaveric Study of Plantar Pressure and Metatarsophalangeal Joint Angle", *Foot & Ankle International*, 33(4): 312-9, 2012.
- 7. Bayomy, A.F., **Aubin, P.M.**, Sangeorzan, B.J., and Ledoux, W.R. "Arthrodesis of the First Metatarsophalangeal Joint: A Robotic Cadaveric Study of Dorsiflexion Angle", *Journal of Bone and Joint Surgery Am.*, 92(8): 1754-64, 2010.
- 8. Aubin, P.M., Cowley, M., and Ledoux, W.R. "Gait Simulation via a 6-DOF Robot with Iterative Learning Control", *IEEE Transactions on Biomedical Engineering*, 55(3): 1237-40, 2008.

### Conference Proceedings (full articles)

- 9. Aubin, P.M., Sallum, H., Correia, A., Walsh, C., and Stirling, L. "A Pediatric Robotic Thumb Exoskeleton for at-Home Rehabilitation: The Isolated Orthosis for Thumb Actuation (IOTA)", *International Conference on Rehabilitation Robotics*, Seattle, WA, USA: 2013, submitted.
- 10. Wehner, M., Quinlivan, B., Aubin, P.M., Martinez-Villalpando, E., Bauman, M., Stirling, L., Holt, K., Wood, R., and Walsh, C. "Design and Evaluation of a Lightweight Soft Exosuit for Gait Assistance", *The IEEE International Conference on Robotics and Automation, Karlsruhe, Germany: 2013.*
- 11. Öpik, R, Hunt, A, Aubin, P.M. and Kruusmaa, M. "Development of High Fidelity Liver and Kidney Phantom Organs for Use with Robotic Surgical Systems", *IEEE International Conference on Biomedical Robotics and Biomechatronics*, Roma, Italy: 2012.
- 12. Aubin, P.M., Whittaker, E., and Ledoux, W.R. "Foot Bone Kinematics at Half and Three Quarters Body Weight: A Robotic Cadaveric Simulation of Stance Phase", *The 15<sup>th</sup> International Conference on Advanced Robotics*, Tallinn, Estonia: 2011.
- 13. Aubin, P.M. and Ledoux, W.R. "Cadaveric Robotic Gait Simulation with Tendon Force Control: A Tool for Biomechanics Research", *International Conference on Applied Bionics and Biomechanics*, Venice, Italy: 2010.

### **Conference Proceedings (abstracts)**

- 14. Aubin, P.M., Serackis, A., and Griškevičius, J. "A Ground Reaction Force Artificial Neural Network Classifier for the Diagnosis of Parkinson's Disease," *Proceeding of the XXIII Congress of the International Society of Biomechanics*, Brussels, Belgium: 2011.
- 15. Whittaker, E., Aubin, P.M., and Ledoux, W.R. "Changes in Foot Bony Motion Under Different Loading Conditions Using a Cadaveric Robotic Gait Simulator", *Proceeding of the 35th Annual Meeting of the American Society of Biomechanics*, Long Beach, CA, USA: 2011.

- 16. Aubin, P.M., Whittaker, E., and Ledoux, W.R. "A Cadaveric Robotic Gait Simulator with Fuzzy Logic Vertical Ground Reaction Force Control", *Proceedings of the 2nd Congress of the International Foot and Ankle Biomechanics Community*, Seattle, WA, USA: 2010.
- 17. Whittaker, E., Aubin, P.M., and Ledoux, W.R. "In Vitro Description of Foot Bony Motion Using A Cadaveric Robotic Gait Simulator", *Proceedings of the 34rd Annual Meeting of the American Society of Biomechanics*, Providence, Rhode Island, USA: 2010.
- 18. Aubin, P.M., Whittaker, E., and Ledoux, W.R. "A Cadaveric Robotic Gait Simulator with Fuzzy Logic Vertical Ground Reaction Force Control", *Proceedings of the 34rd Annual Meeting of the American Society of Biomechanics*, Providence, Rhode Island, USA: 2010.
- 19. Whittaker, E., Aubin, P.M, and Ledoux, W.R. "In Vitro Description of Foot Bony Motion Using A Cadaveric Robotic Gait Simulator", *Proceedings of the 2nd Congress of the International Foot and Ankle Biomechanics Community*, Seattle, WA, USA: 2010.
- Aubin, P.M. Whittaker, E. and Ledoux, W.R. "A Cadaveric Robotic Gait Simulator with Fuzzy Logic Ground Reaction Force Control", *Proceedings of the Northwest Biomechanics Symposium*, Seattle, WA, USA: 2010.
- Weber, J.R., Aubin, P.M., Sangeorzan, B.J., and Ledoux, W.R. "Crossover Toe Deformity of the Second Metatarsophalangeal Joint: A Robotic Cadaveric Study of Plantar Pressure and Metatarsophalangeal Joint Angle", *Orthopaedic Research Society Annual Meeting Transactions*, New Orleans, LA, USA: 2010.
- 22. Aubin, P.M. and Ledoux, W.R. "The Robotic Gait Simulator: The effect of EMG to Force Estimation", *Proceedings of the 33rd Annual Meeting of the American Society of Biomechanics*, State College, PA, USA: 2009.
- 23. Aubin, P.M. and Ledoux, W.R. "Validation of the Robotic Gait Simulator: A Dynamic Cadaveric Model of the Stance Phase", *Proceedings of the Northwest Biomechanics Symposium*, Pullman, WA, USA: 2009.
- 24. Bayomy, A., Aubin, P.M., Sangeorzan, B.J., and Ledoux, W.R. "Arthrodesis of the First Metatarsophalangeal Joint: A Robotic Cadaveric Study of the Effect of Dorsiflexion Angle on Plantar Pressure", Orthopaedic Research Society Annual Meeting Transactions, Las Vegas, NV, USA: 2009.
- 25. Bayomy, A.F., Aubin, P.M., Sangeorzan, B.J., and Ledoux, W.R. "Selected Abstracts: Orthopedic Research Society Meeting", *Foot and Ankle International*, 30(8): 803, 2009.
- 26. Aubin, P.M., and Ledoux, W.R. "Development of a 6-DOF Robotic Gait Simulator with Force Feedback Control", *International Symposium on Robotics in Biomechanics*, Banff, Alberta, Canada, 2008.
- 27. Jackson, L.T., Aubin, P.M., Sangeorzan, B.J. and Ledoux, W.R., "A Robotic Cadaveric Flatfoot Simulation of Stance Phase", *Proceedings of the North American Congress on Biomechanics*, Ann-Arbor MI, USA: 2008.
- 28. Aubin, P.M., Cowley, M., and Ledoux, W.R. "Cadaveric Gait Simulation", *Proceedings of the 30th Annual Meeting of the American Society of Biomechanics*, Blacksburg, VA, USA: 2006.
- 29. Aubin, P.M., Cowley, M., and Ledoux, W.R.. "Cadaveric Gait Simulation", *Proceeding of the Northwest Biomechanics Symposium*, Vancouver, BC, Canada: 2006.
- 30. Aubin, P.M., Cowley, M., and Ledoux, W.R. "Dynamic Gait Simulation: Neutrally Aligned and Pathologic Feet", *Proceeding of the Northwest Biomechanics Symposium*, Seattle, WA, USA: 2005.

#### Dissertation

 Aubin, P.M. "The Robotic Gait Simulator: A Dynamic Cadaveric Foot and Ankle Model for Biomechanics Research", Ph.D. dissertation, Department of Electrical Engineering, University of Washington, 2010.

## Invited Talks

- 32. *Tallinn University of Technology*, Tallinn, Estonia, April 19<sup>th</sup>, 2011. "The Robotic Gait Simulator: A Dynamic Cadaveric Foot and Ankle Model for Biomechanics Research".
- 33. *Bialystok Technical University*, Bialystok, Poland, October 28<sup>th</sup>, 2010. "The Robotic Gait Simulator: A Dynamic Cadaveric Foot and Ankle Model for Biomechanics Research".
- 34. *Vilnius Gediminas Technical University*, Vilnius, Lithuania, November 26<sup>th</sup>, 2010. "An Introduction to MATLAB for Biomechanics Research".
- 35. *Veteran Affairs Hospital*, Young Investigators Symposium, Seattle, WA, USA, August 19<sup>th</sup>, 2009. "A Fuzzy Logic Vertical Ground Reaction Force Controller for the Robotic Gait Simulator".
- 36. *Veteran Affairs Hospital*, Seattle, WA, USA, March 3<sup>rd</sup>, 2009: "LabVIEW Programming Techniques for Real-time Data Processing and Control".
- 37. *Veteran Affairs Hospital*, Young Investigators Symposium, Seattle, WA, USA, August 13<sup>th</sup>, 2008. "Taking The First Step: New Features That Make the Robotic Gait Simulator Dynamic".
- 38. *Veteran Affairs Hospital*, Young Investigators Symposium, Seattle, WA, USA, August 9<sup>th</sup>, 2007. "Tendon Force Control for the Robotic Gait Simulator".
- 39. Department of Biomedical Engineering Cleveland Clinic, Cleveland, Ohio, USA, October 19<sup>th</sup>, 2006. "Cadaveric Gait Simulation".
- 40. *Veteran Affairs Hospital*, Young Investigators Symposium, Seattle, WA, USA, August 8<sup>th</sup>, 2006. "Iterative Learning Control".