Andy Borum

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RESEARCH INTERESTS

My research focuses on optimization and its applications in the following areas:

Mechanics – equilibrium and stability of elastic structures, geometric mechanics

Control – optimal control theory, geometric control theory

Robotics – manipulation of deformable objects, path planning

EDUCATION

University of Illinois at Urbana-Champaign — 2012 – present
Ph.D., Aerospace Engineering (*in progress*)
M.S., Aerospace Engineering

Virginia Tech — 2008 – 2012
B.S., Engineering Science and Mechanics
B.S., Mathematics

RESEARCH EXPERIENCE

NSF Graduate Research Fellow – Bretl Research Group — 2012 – present
University of Illinois at Urbana-Champaign
Advised by Timothy Bretl

Senior Thesis Research – Ross Dynamics Lab — 2011 – 2012
Virginia Tech
Advised by Shane Ross

Undergraduate Research Assistant – Materials Response Group — 2009 – 2012
Virginia Tech
Advised by David Dillard, Raymond Plaut, and Douglas Holmes

TEACHING EXPERIENCE

Graduate Teaching Assistant – Aerospace Control Systems — Spring 2017
University of Illinois at Urbana-Champaign
Supervised by Timothy Bretl

HONORS AND AWARDS

University of Illinois College of Engineering Mavis Future Faculty Fellowship, Fall 2016

Finalist, Best Conference Paper Award at the IEEE International Conference on Robotics and Automation (ICRA), Spring 2014

National Science Foundation Graduate Research Fellowship, Fall 2013

University of Illinois Aerospace Engineering Stillwell Fellowship, Fall 2012

Virginia Tech Engineering Science and Mechanics Outstanding Senior, Spring 2012

Dan Pletta Award for Outstanding Senior Research Project, Spring 2012

Howard Stone Award for Outstanding Computational Senior Research Project, Spring 2012

2nd Place, Michelin Best Poster Competition at the 35th Adhesion Society Meeting, Spring 2012

Virginia Space Grant Consortium Undergraduate STEM Research Scholarship, Spring 2011

REFEREED JOURNAL PUBLICATIONS

6. A. Borum and T. Bretl, Reduction of sufficient conditions for optimal control problems with subgroup symmetry, *IEEE Transactions on Automatic Control*, 62(7), 3209–3224, 2017.

5. A. Borum and T. Bretl, Sufficient conditions for a path-connected set of local solutions to an optimal control problem, *SIAM Journal on Applied Mathematics*, 76(3), 976–999, 2016.

4. R. H. Plaut, A. Borum, D. P. Holmes, and D. A. Dillard, Falling vertical chain of oscillators, including collisions, damping, and pretensioning, *Journal of Sound and Vibration*, 349, 195–205, 2015.

3. D. P. Holmes, A. Borum, B. F. Moore III, R. H. Plaut, and D. A. Dillard, Equilibria and instabilities of a Slinky: Discrete model, *International Journal of Non-Linear Mechanics*, 65, 236–244, 2014.

2. R. H. Plaut, A. Borum, and D. A. Dillard, Analysis of carbon nanotubes and graphene nanoribbons with folded racket shapes, *Journal of Engineering Materials and Technology*, 134(2), 021009, 2012.

1. R. H. Plaut, D. A. Dillard, and A. Borum, Collapse of heavy cantilevered elastica with frictional internal support, *Journal of Applied Mechanics*, 78(4), 041011, 2011.

REFEREED CONFERENCE PUBLICATIONS

6. A. Borum and T. Bretl, Helices, relative equilibria, and optimality on the special Euclidean group, in *IEEE Conference on Decision and Control (CDC)*, 2016.

5. A. Borum and T. Bretl, The free configuration space of a Kirchhoff elastic rod is path-connected, in *IEEE International Conference on Robotics and Automation (ICRA)*, 2015.

4. O. Roussel, A. Borum, M. Taïx, and T. Bretl, Manipulation planning with contacts for an extensible elastic rod by sampling on the submanifold of static equilibrium configurations, in *IEEE International Conference on Robotics and Automation (ICRA)*, 2015.

3. A. Borum and T. Bretl, Geometric optimal control for symmetry breaking cost functions, in *IEEE Conference on Decision and Control (CDC)*, 2014.

2. M. Mukadam, A. Borum, and T. Bretl, Quasi-static manipulation of a planar elastic rod using multiple robotic grippers, in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2014.

1. A. Borum, D. Matthews, and T. Bretl, State estimation and tracking of deforming planar elastic rods, in *IEEE International Conference on Robotics and Automation (ICRA)*, 2014. Finalist for ICRA Best Conference Paper Award

NON-REFEREED CONFERENCE PUBLICATIONS AND PRESENTATIONS

3. A. Borum, J. Burns, P. Wentzel, A. Andreyev, and S. Ross, Asteroid capture using a binary exchange mechanism, *Virginia Space Grant Consortium Student Research Conference*, 2012.

2. A. Borum, R. H. Plaut, and D. A. Dillard, Analysis of carbon nanotubes and graphene nanoribbons with folded racket shapes, *35th Annual Meeting of the Adhesion Society*, 2012. 2nd place in the Michelin Best Poster Competition

1. A. Borum, R. H. Plaut, and D. A. Dillard, Analysis of carbon nanotubes and graphene nanoribbons with folded racket shapes, *78th Annual Meeting of the Southeastern Section of the American Physical Society*, 2011.

PROFESSIONAL SERVICE

Scholarly Review
IEEE Transactions on Robotics
IEEE Transactions on Automation Science and Engineering
IEEE Robotics and Automation Letters
Applied Mathematical Modeling
IEEE International Conference on Robotics and Automation (ICRA)
IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
Workshop on the Algorithmic Foundations of Robotics (WAFR)
European Control Conference (ECC)

COMMUNITY OUTREACH

Education Justice Project   2013 – Present
Danville Correctional Center
Danville, Illinois

My work with the Education Justice Project focuses on increasing access to STEM education for incarcerated students. To achieve this goal, I have served in the following roles:

Computer Lab Coordinator – I currently manage scheduling, volunteer recruiting, and program organization in the computer lab at Danville Correctional Center. I also oversee acquisitions of hardware and software, and I identify funding opportunities. I have successfully applied for a grant of $1,650 from the Community Foundation of East Central Illinois.

Workshop Facilitator – I have facilitated workshops on a variety of STEM topics, including computer programming using Python, computer graphics using OpenGL, data analysis and machine learning for bioinformatics research, and basic computer skills.

Reading Group Facilitator – I have facilitated a summer reading group on mathematical physics.

Technical Support Group Facilitator – I currently facilitate a student-led group that provides technical support in the computer lab at Danville Correctional Center.

Mathematics and Science Tutor – I have assisted students with assignments for STEM courses including Aerospace Control Systems, Introduction to Robotics, and Non-Euclidean Geometry.