BLAKE R. BUCHANAN

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RESEARCH

My research interests lie at the interface of biologically inspired robotics, multi-robot systems, and applied mathematics. More specifically, I am interested in applying methods from dynamical systems, geometric mechanics, and optimal control to endow robots with control strategies capable of leveraging the dynamics of their environment.

EDUCATION

Carnegie Mellon University School of Computer Science August 2020
Master of Science in Robotics Cumulative GPA: 3.76 / 4.00
Robotics Institute

University of North Carolina at Charlotte May 2018
Bachelor of Science in Mechanical Engineering Cumulative GPA: 3.487 / 4.000
Department of Mechanical Engineering and Engineering Science

PUBLICATIONS

B. Buchanan, T. Dear, S.D. Kelly, M. Travers, H. Choset, (2021) "The Geometric Structure of Externally Actuated Planar Locomoting Systems in Ambient Media," *arXiv.org Preprint, Submitted to IEEE Transactions on Robotics*, (PDF)

B. Buchanan (2020) "Mechanics and Control of Coupled Interactions in Ambient Media," *Master's Thesis*, Carnegie Mellon University, Pittsburgh, PA. (PDF)

B. Buchanan, M. Travers, H. Choset, and S. D. Kelly (2020) "Stability and Control of Chaplygin Beanies Coupled to a Platform through Nonholonomic Constraints," *ASME DSCC 2020* (PDF)

T. Dear, **B. Buchanan**, R. Abrajan-Guerrero, S. D. Kelly, M. Travers, and H. Choset, (2019) "Locomotion of a multi-link nonholonomic snake robot with passive joints," *International Journal of Robotics Research* (PDF)

TALKS

Buchanan, B. (2019, May). *Modeling and Dynamics of Planar Swimmers Coupled through Wake Vorticity*. Presentation given at the 2019 SIAM Conference on Applications of Dynamical Systems (DS19)

Buchanan, B., Travers, M. Choset, H., Kelly S. (2020, October). *Stability and Control of Chaplygin Beanies Coupled to a Platform Through Nonholonomic Constraints*. Presentation given at the ASME 2020 Dynamic Systems and Control Conference (mp4)

EXPERIENCE

The Robotics Institute at Carnegie Mellon University August 2020 - Present
Biorobotics Lab, Research Staff

- Introduced a novel perspective in finding optimal controls for nonholonomic multi-robot systems in dynamic environments using geometric optimal control techniques
- Investigated the role of symmetries in a robot's shape space for identifying and deploying families of gaits for affecting locomotion and environment manipulation
- Developed software in Python, Julia, and MATLAB programming languages to test and validate dynamical systems and control strategies

The Robotics Institute at Carnegie Mellon University August 2018 - August 2020
Biorobotics Lab, Graduate Research Assistant

- Proved stability of an underactuated elastically driven robot in a dynamic environment
- Made progress in proving the stability of a *multi-agent* nonholonomic locomoting system in a dynamic environment

- Developed a simulation and implemented a PID controller for a novel impulsively actuated two-dimensional aquatic vehicle in an inviscid fluid

The Robotics Institute at Carnegie Mellon University May 2017 - August 2017
Biorobotics Lab, Robotics Intern

- Designed and developed a robot that contributed to published research concerning the effects of elastic elements on the locomotion of biologically inspired snake robots

University of North Carolina at Charlotte May 2016 - May 2018
Faculty Lab, Undergraduate Research Assistant

- Designed experiments and developed motion control electronics for biologically inspired terrestrial and aquatic robots
- Developed an affordable RTK-based differential positioning Raspberry Pi package to track the position of biologically inspired terrestrial and aquatic robots

University of North Carolina at Charlotte January 2016 - May 2018
Department of Mechanical Engineering, Undergraduate Teaching Assistant

- Delivered supplemental lectures for undergraduate dynamics courses
- Assisted students in learning the PTC Creo CAD package

CONFERENCES Society for Industrial and Applied Mathematics Conference on Dynamical Systems (2019)
American Society of Mechanical Engineers Dynamic Systems and Control Conference (2020)

PROJECTS **Swimming In Potential Flow** (GitHub)

- Implemented a two-dimensional fluid model of a flexible Joukowski foil in point vortex flows using the Julia programming language

PID Control for Planar Aquatic Vehicle in Point Vortex Flows (Project Website)

- Developed a dynamic model for a novel fluid-propulsive aquatic vehicle in an ideal fluid that exerts control over its motion using impulsive fluid-ejection events
- Implemented PID control for stabilization of aquatic vehicle about specified set points

Bipedal Walking for Optimal Control and Reinforcement Learning Course

- Implemented direct collocation trajectory optimization to find optimal trajectories for a cartpole swing-up task and a single-step task for a five-link bipedal walking model

Underactuated Robot Swarm for Math Fundamentals for Robotics Course

- Developed a dynamic model and implemented control for multiple nonholonomic agents on a movable platform

COURSEWORK Underactuated Robots / Machine Learning / Kinematics, Dynamics, and Control / Math Fundamentals for Robotics / Convex Optimization / Computer Vision / Optimal Control / Advanced Topics in Dynamics / Nonlinear Control

PROGRAMMING Python, Julia, MATLAB, Wolfram Mathematica