

TIMOTHY WOLFE BRETL

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EDUCATION

- 2000-2005 Stanford University, Stanford, CA
Ph.D. in Aeronautics and Astronautics
- 1999-2000 Stanford University, Stanford, CA
M.S. in Aeronautics and Astronautics
- 1995-1999 Swarthmore College, Swarthmore, PA
B.S. with high honors in Engineering
B.A. in Mathematics

DISSERTATION

“Multi-Step Motion Planning: Application to Free-Climbing Robots.”

Presents a framework for computing non-gaited, multi-step, free-climbing motions, a set of algorithms to support this framework, and an operational, integrated implementation for a real robot. Readers: Stephen Rock (adviser), Jean-Claude Latombe, Sanjay Lall.

ACADEMIC AWARDS

- 2002-2004 Herbert Kunzel Stanford Graduate Fellowship
- 1999-2002 National Defense Science and Engineering Graduate Fellowship
- 1999-2002 National Science Foundation Graduate Research Fellowship (honorary)
- 1999 McCabe Engineering Award (top engineering graduate at Swarthmore College)
- 1999 Heinrich W. Brinkmann Mathematics Prize (best paper on a mathematical subject at Swarthmore College)

WORK EXPERIENCE

- 2006-present Assistant Professor, University of Illinois at Urbana-Champaign, Urbana, IL.
Department of Aerospace Engineering.
- 2005-2006 Postdoctoral Research Affiliate, Stanford University, Stanford, CA.
Stanford Artificial Intelligence Laboratory, Department of Computer Science.
- Initiated work to automatically synthesize motion strategies that enable legged robots to navigate steep or uneven terrain.
 - Led research program to develop planning software for a six-legged lunar vehicle, in collaboration with NASA Jet Propulsion Laboratory.
 - Led design and construction of a new climbing and rappelling robot testbed.
 - Supervised 4 graduate students' work.

- 2000-2005 Research Assistant, Stanford University, Stanford, CA.
Aerospace Robotics Laboratory, Department of Aeronautics and Astronautics.
- Founded the interdepartmental “free-climbing robot” research program that currently involves 3 professors and 6 students at Stanford University and 6 researchers at NASA Jet Propulsion Laboratory. Co-authored winning NSF and NASA proposals that support the program.
 - Developed a motion planner for free-climbing robots, which rely on frictional contact with rock features to avoid falling.
 - Breaks configuration space into manifolds associated with each contact state. Picks manifolds to explore by generating a candidate sequence of footfalls first. Explores these manifolds quickly by using the interaction between static equilibrium and the topology of closed kinematic chains.
 - Integrated an embedded control system and a graphical user interface.
 - Enabled real robotic free-climbing, in collaboration with NASA-JPL.
 - Engaged a wide audience with talks to industry, academia, and the public.

COURSES TAUGHT

- Fall 2006 AE 498MPA: Motion Planning for Aerospace Vehicles.
Aerospace Engineering, University of Illinois at Urbana-Champaign.
- This class provides an introduction to motion planning, focusing on its application to autonomous vehicles. First, we will review the basic mathematics and algorithmic techniques. Then, a number of case studies (cars, underwater vehicles and spacecraft, unmanned aerial vehicles, air traffic control) will be used to look at more advanced topics. The course will culminate in student projects. Appropriate background material in mechanics, control, and optimization will be introduced as needed.
- Spring 2007 AE 252: Introduction to Aerospace Dynamics.
Aerospace Engineering, University of Illinois at Urbana-Champaign.
- Kinematics and dynamics of particle motion; methods of work-energy and impulse-momentum; kinematics of plane motion of rigid bodies; moving reference frames; moments of inertia.

PROFESSIONAL ACTIVITIES

Paper referee: IEEE Transactions on Robotics, ASME Journal of Applied Mechanics, and International Journal of Robotics Research.

COMMUNITY INVOLVEMENT

- 2005-present Co-editor of the San Francisco Religious Society of Friends (Quaker) monthly newsletter (volunteer).
- 2003-2004 Head route-setter at the Stanford University Climbing Wall. Co-created the first annual Stanford climbing competition.

INVITED TALKS

“Getting from A to B: Education, Life... and Free-Climbing Robots?” (2005). Keynote Speech, Cum Laude Induction Ceremony, The Blake School, Minneapolis, MN.

“Lemur IIb: A Free-Climbing Robot” (2005). Seminar Series ME396: Design and Manufacturing Forum, Stanford University, Stanford, CA.

“Motion Planning for Climbing Robots” (2003). Seminar, Honda Research Institute, Mountain View, CA.

JOURNAL PUBLICATIONS

T. Bretl. “Motion Planning of Multi-Limbed Robots Subject to Equilibrium Constraints: The Free-Climbing Robot Problem” (2006). *International Journal of Robotics Research*, 25(4):317-342.

CONFERENCE PUBLICATIONS

K. Hauser, T. Bretl, K. Harada, and J.C. Latombe. “Using Motion Primitives in Probabilistic Sample-Based Planning for Humanoid Robots” (2006). Workshop on the Algorithmic Foundations of Robotics (WAFR), New York, NY.

K. Hauser, T. Bretl, J.C. Latombe, and B. Wilcox. “Motion Planning for a Six-Legged Lunar Robot” (2006). Workshop on the Algorithmic Foundations of Robotics (WAFR), New York, NY.

T. Bretl and S. Lall. “A Fast and Adaptive Test of Static Equilibrium for Legged Robots” (2006). *IEEE Int. Conf. on Robotics and Automation (ICRA)*, Orlando, FL.

K. Hauser, T. Bretl, and J.C. Latombe. “Non-Gaited Humanoid Motion Planning” (2005). *IEEE International Conference on Humanoid Robots*, Tsukuba, Japan.

K. Hauser, T. Bretl, and J.C. Latombe. “Learning-Assisted Multi-Step Planning” (2005). *IEEE International Conference on Robotics and Automation (ICRA)*, Barcelona, Spain.

T. Bretl, S. Lall, J.C. Latombe, and S. Rock. “Multi-Step Motion Planning for Free-Climbing Robots” (2004). Workshop on the Algorithmic Foundations of Robotics (WAFR), Utrecht/Zeist, The Netherlands.

T. Bretl, S. Rock, J.C. Latombe, B. Kennedy, and H. Aghazarian. “Free-Climbing with a Multi-Use Robot” (2004). *International Symposium on Experimental Robotics (ISER)*, Singapore.

T. Bretl, J.C. Latombe, and S. Rock. “Toward Autonomous Free-Climbing Robots” (2003). *International Symposium of Robotics Research (ISRR)*, Siena, Italy.

T. Bretl, S. Rock, and J.C. Latombe. “Motion Planning for a Three-Limbed Climbing Robot in Vertical Natural Terrain” (2003). *IEEE International Conference on Robotics and Automation (ICRA)*, Taipei, Taiwan.

T. Bretl, T. Miller, S. Rock, and J.C. Latombe. “Climbing Robots in Natural Terrain” (2003). *International Symposium on Artificial Intelligence, Robotics, and Automation in Space (iSAIRAS)*, Nara, Japan.

T. Bretl and S. Rock. "Planning Robust Dynamic Transitions for Enhanced Mobility of Planetary Rovers" (2002). IFAC Conference on Mechatronic Systems, Berkeley, CA.

T. Bretl and S. Rock. "Robust Execution of Aggressive Maneuvers for Planetary Robotics" (2002). AIAA Guidance, Navigation, and Control Conference and Exhibit (AIAA-GNC), Monterey, CA.

C. Clark, T. Bretl, and S. Rock. "Applying Kinodynamic Randomized Motion Planning with a Dynamic Priority System to Multi-Robot Space Systems" (2002). IEEE Aerospace Conference, Big Sky, MT.

K. Stein, R. Benney, T. Tezduyar, V. Kalro, J. Potvin, and T. Bretl. "Fluid-Structure Interaction Simulation of a Cross Parachute: Comparison of Numerical Predictions with Wind Tunnel Data" (1999). CEAS/AIAA Aerodynamic Decelerator Systems Technology Conference and Seminar, AIAA Paper 99-1725, Toulouse, France.

Reprints are available at <http://www.ae.uiuc.edu/~tbretl/publications.htm>