

Umashankar Nagarajan

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RESEARCH INTERESTS

Robotics, Dynamics and Control, Motion Planning, Mobile Robots, Balancing Systems, Underactuated Systems, Integrated Planning and Control, Human-Robot Physical Interaction

EDUCATION

The Robotics Institute, Carnegie Mellon University

DOCTOR OF PHILOSOPHY IN ROBOTICS

Advisor: Ralph Hollis

MASTER OF SCIENCE IN ROBOTICS

Advisor: Ralph Hollis

Pittsburgh, PA, USA

June 2012 (Expected)

CGPA: 3.75/4.0

December 2008

CGPA: 3.83/4.0

Birla Institute of Technology and Science

BACHELOR OF ENGINEERING (HONS.) IN MECHANICAL

Advisor: Himanshu Dutt Sharma

Pilani, India

December 2006

CGPA: 9.17/10.0

RESEARCH EXPERIENCE

The Robotics Institute, Carnegie Mellon University

GRADUATE STUDENT RESEARCHER

Developed planning and control algorithms for the ballbot, a human-sized robot that balances on a ball. Developed shape trajectory planners that use dynamic constraint equations to plan motions for the arm and body angles of the ballbot in order to achieve the desired ball motion. Developed an integrated planning and control framework that allows the ballbot to plan in the space of motion policies to achieve navigation tasks gracefully.

RESEARCH ENGINEER

Pittsburgh, PA, USA

August 2009 – Present

January – May, 2009

Developed control software and graphical user interface for the ballbot, which enables the user to wirelessly monitor the robot's operation, issue commands to the robot and teleoperate it.

GRADUATE STUDENT RESEARCHER

August 2007 – December 2008

Developed control algorithms that enable the ballbot to balance reliably, be robust to disturbances including kicks, shoves and collisions with objects. Explored a variety of human-robot physical interaction tasks with the ballbot.

Honda Research Institute USA, Inc.

SUMMER RESEARCH INTERN

Developed control and planning algorithms that use foot placement and inertia shaping strategies to cause safe fall of a humanoid robot without causing damage to its surrounding objects, when the robot fall is inevitable.

Mountain View, CA, USA

June – August, 2009

Central Electronics Engineering Research Institute

PROJECT ASSISTANT

Developed an intelligent system design procedure using fuzzy logic that generates percepts from sensory information and generates actions from these percepts for pre-determined tasks.

Pilani, India

February – May, 2007

SUMMER RESEARCH INTERN

June – July, 2006

Designed, trained and simulated adaptive neuro-fuzzy controllers for stabilization of an autonomous bicycle.

Birla Institute of Technology and Science

UNDERGRADUATE RESEARCHER

Modeled an autonomous bicycle system and analyzed its stability characteristics and the relationship between lean and steer. Analyzed the effect of the presence of a rigid rider on stabilization of the autonomous bicycle model. Developed a variety of fuzzy logic controllers for stabilization of the autonomous bicycle model.

Pilani, India

June 2004 – December 2006

TEACHING EXPERIENCE

The Robotics Institute, Carnegie Mellon University

Teaching Assistant for Introduction to Feedback Control Systems

Pittsburgh, PA, USA

January – May, 2010

Birla Institute of Technology and Science

Professional Assistant for Control Systems

Pilani, India

August 2005 – December 2006

PATENTS

- Ambarish Goswami, **Umashankar Nagarajan** and Yoshiaki Sakagami, “Humanoid Fall Direction Change Among Multiple Objects”, *Honda Motor Co., Ltd. (Patent Pending)*, June 2010.

JOURNAL PAPERS

- **Umashankar Nagarajan** and Ralph Hollis, “Shape Space Planner for Shape-Accelerated Balancing Mobile Robots”, *IEEE Transactions on Robotics (Under Review)*, 2011.
- **Umashankar Nagarajan**, George Kantor and Ralph Hollis, “The Ballbot: An Omnidirectional Balancing Mobile Robot”, *IEEE Transactions on Robotics (Under Review)*, 2011.
- Ambarish Goswami, Seung-kook Yun, **Umashankar Nagarajan**, Sung-Hee Lee, KangKang Yin and Shivaram Kalyanakrishnan, “Direction-Changing Fall Control in Humanoid Robots: Theory and Experiments”, *International Journal of Robotics Research (Under Review)*, 2011.

SELECTED REFEREED CONFERENCE PAPERS

- **Umashankar Nagarajan**, George Kantor and Ralph Hollis, “Integrated Planning and Control for Graceful Navigation of Shape-Accelerated Underactuated Balancing Mobile Robots”, *Accepted for publication at the IEEE International Conference on Robotics and Automation (ICRA)*, May 2012.
- **Umashankar Nagarajan**, Byungjun Kim and Ralph Hollis, “Planning in High-dimensional Shape Space for a Single-wheeled Balancing Mobile Robot with Arms”, *Accepted for publication at the IEEE International Conference on Robotics and Automation (ICRA)*, May 2012.
- **Umashankar Nagarajan**, George Kantor and Ralph Hollis, “Hybrid Control for Navigation of Shape-Accelerated Underactuated Balancing Systems”, *Proceedings of the 49th IEEE Conference on Decision and Control (CDC)*, pp. 3566 – 3571, December 2010.
- **Umashankar Nagarajan**, “Dynamic Constraint-based Optimal Shape Trajectory Planner for Shape-Accelerated Underactuated Balancing Systems”, *Proceedings of Robotics: Science and Systems (RSS)*, June 2010.
- **Umashankar Nagarajan** and Ambarish Goswami, “Generalized Direction Changing Fall Control of Humanoid Robots among Multiple Objects”, *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA)*, pp. 3316 – 3322, May 2010.
- **Umashankar Nagarajan**, George Kantor and Ralph Hollis, “Trajectory Planning and Control of a Dynamically Stable Single Spherical Wheeled Mobile Robot”, *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA)*, pp. 3743 – 3748, May 2009.
- **Umashankar Nagarajan**, Anish Mampetta, George Kantor and Ralph Hollis, “State-Transition, Balancing, Station Keeping and Yaw Control for a Dynamically Stable Single Spherical Wheel Mobile Robot”, *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA)*, pp. 998 – 1003, May 2009.
- **Umashankar Nagarajan**, George Kantor and Ralph Hollis, “Human-Robot Physical Interaction with Dynamically Stable Mobile Robots”, *Proceedings of the ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, pp. 281 – 282, March 2009.

A more detailed list of publications is available at: <http://www.cs.cmu.edu/~unagaraj/publications.html> .

The robot videos are available at: <http://www.cs.cmu.edu/~unagaraj/videos.html> .

TECHNICAL REPORTS

- **Umashankar N.**, “Simulation Analysis of Rider Effect on Bicycle Stabilization”, *Undergraduate Thesis*, Birla Institute of Technology and Science, Pilani, December 2006.

COMPUTER SKILLS

Languages: C and C++

Softwares: MATLAB, SIMULINK, Mathematica, Pro/Engineer, Altium Designer (Protel) and Open Dynamics Engine

Operating Systems: Microsoft Windows, UNIX, Linux and QNX

HONORS AND ACTIVITIES

- Reviewer for the IEEE International Conference on Robotics and Automation (ICRA), 2010 – 2012
- Reviewer for the IEEE/RSJ International Conference on Intelligent Robotics and Systems (IROS), 2008, 2010 – 2011
- Recipient of the Robotics Graduate Fellowship, 2008 – Present
- IEEE Graduate Student Member, 2007 – Present
- Recipient of BITS Pilani Merit-cum-Need Scholarship, 2003 – 2006