

# Richard J. Roberts

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Ph.D. Student, Robotics

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- Research Interests** Mobile robot vision and navigation using bio-inspired methods and machine learning.
- Education** **Ph.D. Student, Robotics**, Georgia Institute of Technology, Atlanta, GA 2007 – present  
**B.S. Mechanical Engineering**, Georgia Institute of Technology, Atlanta, GA 2001 – 2007
- Selected Projects and Publications**
- Learning Optical Flow Subspaces for Mobile Robots**, with Prof. Frank Dellaert 2007 – present  
Unsupervised learning of linear optical flow subspaces, with direct applications to detection of moving objects by a mobile robot, and to estimating a robot's egomotion. I developed an extension to Probabilistic PCA (Tipping and Bishop, 1999) to model optical flow outliers using a Gaussian mixture model, and an Expectation-Maximization (EM) algorithm to robustly find these linear subspaces. I experimentally validated this method for ego-motion estimation and labeling optical flow anomalies and moving objects, in the moving view of mobile robots and generalized imaging systems.  
**Learning General Optical Flow Subspaces for Egomotion Estimation and Detection of Motion Anomalies.** Richard Roberts, Christian Potthast, and Frank Dellaert. *IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR)*, 2009 (oral presentation, 4% acceptance rate).  
<http://www.cc.gatech.edu/~richard/UnsupFlow/>
- Learning Sensor Reliability**, Microsoft Research Intern with Eric Horvitz and Dan Bohus Summer 2009  
Working with the situated interaction (virtual receptionist) project, I used discriminative training to leverage temporal information to greatly reduce the false-positive rate of a state-of-the-art face detector/tracker system. I developed and compared techniques involving training from hand-labeled examples, training from heuristic-labeled examples, and incorporating future temporal information for label propagation. These methods effectively “specialize” the detector/tracker to the camera used and the specific environment in which it is installed, focusing discriminative power where it is most needed.
- Robots in Education**, Microsoft Research Intern with Stewart Tansley and Jared Jackson Summer 2008  
Developed a back-end for the Myro 3 educational robot software that makes developing robot drivers and front-ends simple, yet flexible and robust. Also implemented, on top of this back-end, a GUI demonstrating real-time robot interaction, video streaming, Python scripting, and embedded simulation.  
I conducted this project in collaboration with the Institute for Personal Robotics in Education (IPRE <http://www.roboteducation.org>). I gave several presentations of this work, internally to the Microsoft Robotics Studio team and collaborating employees, and externally to university faculty at the Microsoft Faculty Summit. I was later invited by IPRE and MSR to demo and discuss their work with teachers and faculty at SIGCSE 2009.  
<http://www.cc.gatech.edu/~richard/Myro3/>
- Learning Applied to Ground Robots (DARPA LAGR)**, with Prof. Tucker Balch 2007 – 2008  
Developed and published a method for interactive robot behavior learning from human example. Implemented a fully-functional interactive learning system using this method, which DARPA tested as part of our robot system. Gave a live robot demonstration of this work to the LAGR program manager in January 2008, at the Southwest Research Institute (SWRI).  
Worked as part of Georgia Tech's LAGR team to develop and maintain our robot software, conduct field testing, and plan how to accomplish the goals set by DARPA while also furthering our research.  
**Interactive Behavior Learning with a Mobile Robot.** Richard Roberts, Charles Pippin, and Tucker Balch. *Journal of Field Robotics, LAGR Special Issue*, 2009.  
<http://www.cc.gatech.edu/~richard/LearnBehav/>  
**Memory-Based Learning for Visual Odometry.** Richard Roberts and Hai Nguyen and Niyant Krishnamurthi and Tucker Balch. *IEEE International Conference on Robotics and Automation*, 2008 (oral presentation).  
<http://www.cc.gatech.edu/~richard/research.html>

- Projects and Publications (cont.)** **Mobile Manipulation**, with Prof. Henrik Christensen 2007  
 Our team developed complete perception and control software, and put it into practice with extensive testing, for a dynamically-balancing Segway robot with a 6-axis arm and gripper. The robot located a coffee cup and coffee maker using vision, filled the cup with coffee, and return the coffee to the user. Particle filters for object detection, and layered PID controllers to compensate for platform motion, made our method robust. Our robot completed all 3 trials required by the "coffee challenge" with no failures.  
**A New Mobile Manipulation Platform for Automatic Coffee Retrieval.** C. Anderson and B. Axelrod and J. P. Case and J. Choi and M. Engel and G. Gupta and F. Hecht and J. Hutchison and N. Krishnamurthi and J. H. Lee and H. D. Nguyen and R. Roberts and J. G. Rogers and A. J. B. Trevor. *Robotics Science and Systems* workshop on Robot Manipulation, 2007. <http://www.cc.gatech.edu/~richard/MobManip/>
- Finite-Element Analysis in Evolutionary Biology**, with J. Todd Streebman, Georgia Tech 2005 – 2007  
 As an undergraduate research assistant, explored using CT-scans and finite-element analysis (FEA) to quantify and compare jaw strength and shape between cichlid fish. Developed analytical and experimental techniques, and data analysis software.  
**Convergence in a Mechanically Complex Phenotype: Detecting Structural Adaptations for Crushing in Cichlid Fishes.** C. Darrin Hulseley and Richard Roberts and Todd Streebman. *Evolution*, 2008. <http://www.cc.gatech.edu/~richard/fea/>
- Place Recognition-based Fixed-Lag Smoothing for Environments with Unreliable GPS.** Roozbeh Mottaghi and Michael Kaess and Ananth Ranganathan and Richard Roberts and Frank Dellaert. *IEEE International Conference on Robotics and Automation*, 2008.
- Community** Volunteer mentor of the Robotics Club at Counterpane School, Fayetteville, GA 2008 – present  
 Providing guidance, lectures, and homework assignments for middle and high school students pursuing robotics projects at Counterpane School. Group of approximately 15 students. Currently exploring sensing and control with LEGO Mindstorms.
- Invited talks** Learning General Optical Flow Subspaces for Egomotion Estimation and Detection of Motion Anomalies, RIM Chat, Georgia Institute of Technology, September 2009.
- Honors and Awards** National Merit Scholarship  
 President's Undergraduate Research Award  
 Georgia Governor's Scholarship  
 Georgia Tech Faculty Women's Club Scholarship
- Skills** Platforms: Windows, Mac OS X, Linux  
 Programming languages: C#, C/C++, OCaml, Java, MATLAB, Lisp, Python  
 Robotics+Vision tools: Microsoft Robotics Developer Studio, IPP, OpenCV, OpenGL, Player/Stage/Gazebo  
 Programming toolkits: .NET 3.5, C++ Standard Template Library (STL), Boost, Glib, Java 1.5 API  
 GUI toolkits: Windows Presentation Foundation (WPF), Windows forms, Gtk, QT, Swing (Java)  
 Mathematical tools: Mathematica, MATLAB  
 Other: LaTeX, LyX, CVS, Subversion (SVN)  
 Languages: English (native), French (intermediate)
- Leadership and Extra-curriculars** Georgia Tech Cycling Team 2003 – 2006  
 Served as Vice President from 2004 to 2005. Men's B category mountain biking conference champion in 2005. Participated in 2005 mountain bike nationals.
- Georgia Tech Off-Road 2002 – 2005  
 Served as drivetrain team leader from 2003 to 2005, designed and built brake system and modified manufactured gearbox. Designed and built custom gearbox with integrated locking differential.
- Memberships** IEEE  
 Society of Automotive Engineers (SAE)

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