

CURRICULUM VITAE

RESEARCH INTERESTS

I research ways to help interactive robots see and understand their world. I am especially excited about using computer vision to help robots learn to interact with objects and their environment with limited prior knowledge. By enabling more robot interaction learned from vision, we can facilitate better human-robot teaming and the positive social improvements that will emerge from safe, effortless collaboration between robots and humans. Specifically, I am interested in:

ROBOTICS: Active SLAM, sensorimotor coordination, learning from demonstration, human-robot teaming, task learning, manipulation and object interaction.

COMPUTER VISION: Semantic segmentation, learning from synthetic data, affordance detection, visual SLAM, geometry-based reasoning, object detection, and object discovery.

EDUCATION

Doctor of Philosophy (in progress) – **Georgia Institute of Technology**, Atlanta, GA 2016-Present

- Major: Robotics
 - Focus: Computer Vision, Artificial Intelligence, Human Robot Interaction
- Advisors: Dr. Sonia Chernova and Dr. Irfan Essa

Masters of Science – **University of Pennsylvania**, Philadelphia, PA 2011-2013

- Major: Robotics
- Advisor: Dr. Kostas Daniilidis

Bachelors of Science – **Georgetown University**, Washington, D.C. 2007-2011

- Majors: Physics, Mathematics

REFEREED PUBLICATIONS

1. **Balloch, J. C.**, Aggraval, V., Essa, I., Chernova, S. “Real-time Semantic Segmentation for Robot Vision using Curriculum Learning with Synthetic Data.” *IEEE International Conference on Robotics and Automation (ICRA)* (under review), 2017.
2. **Balloch, J. C.**, Chernova, S. “An RGBD segmentation model for robot vision learned from synthetic data.” *Robotics Science and Systems (RSS): Workshop on Spatial-Semantic Representations in Robotics*, 2017.
3. Endo, Y., **Balloch, J.**, Grushin, A., Lee, M.W., Handelman, D. “Landmark-Based Robust Navigation for Tactical UGV Control in GPS-Denied Communication-Degraded Environments.” *SPIE Unmanned Systems Technology XVIII*, 2016.

4. West, R. A., Ovanessian, A., Turtle, E. P., Ray, T., **Balloch, J.**, Dumont, P., Lavvas, P., Lorenz, R., Rannou, P. "Titan's Detached Haze and Polar Vortex: Large-Amplitude Seasonal Variations." *Lunar and Planetary Science Conference*, 43, 2012.
5. West, R. A., **Balloch, J.**, Dumont, P., Lavvas, P., Lorenz, R., Rannou, P., Turtle, E. P., Ray, T. "The Evolution of Titan's detached haze layer near equinox in 2009." *Geophysical Research Letters*, 38, doi: 10.1029/2011GL046843, 2011.

PROFESSIONAL RESEARCH EXPERIENCE

Graduate Researcher – Georgia Institute of Technology

2016-Present

- ♦ Exploring solutions to computer vision problems in robotics, focusing on visual robot interaction with humans and objects.
- ♦ Researched ways in which synthetic visual data generated from simulation can benefit real-time semantic segmentation for a robot
 - Investigated the degree to which pretraining on a large amount of synthetic data improves performance on real data
 - Showed that our method of training on synthetic data in a curriculum outperforms both training from scratch and standard data augmentation practices like pretraining on ImageNet.
 - Investigated the importance of the similarity of synthetic data to the real data when being trained in a curriculum, and show that while similarity is beneficial, more data has even greater benefits.
 - Work presented at workshop at 2017 Conference on Robotics: Science and Systems, and is under review for publication at the 2018 International Conference on Robotics Automation.
- ♦ Currently investigating how to improve planning with visual simultaneous localization and mapping by utilizing semantic segmentation of the 3D map, and planning relative to learned spatial object co-occurrences.

Robotics Engineer – Intelligent Automation, Inc.

2013-2016

- ♦ Specialized in design and development of computer vision, sensor fusion, and control algorithms for robotics.
- ♦ Collaborated with UCLA on the DARPA MSEE and SIMPLEX projects
 - Leading the effort working with a Baxter robot for autonomous furniture assembly of IKEA table
 - Developed C++ Windows interface allowing Baxter control over TCP and camera functionality over UDP

- ◆ C++ computer vision research development for Bearing-based Landmark Navigation robotic system for Army in collaboration with Rutgers:
 - Improved contour feature tracking algorithm to object segmentation persistence of 94% using mean shift and optimized code to increase run-time efficiency from 0.4 fps to 3 fps with HD streaming input.
 - Designed omnidirectional camera sensor head from four cameras with IMU and developed API for integration with our robot platform
- ◆ Implemented mobility and OCU control systems for dual-manipulator robot and localization for maintainer robot as part of Multi-Arm Robotic Control System program for the Navy as part of the AEODRS effort
 - Led integration effort of our robotic control system, Behavior Development Studio, with the AEDORS 2.0 standard, making it compatible with all five modules
 - Demonstrated ease of use and high-level control with limited operator training at the DARPA Robotic Challenge Trials Expo in Homestead, FL in December 2013

Graduate Student Researcher – GRASP Lab, University of Pennsylvania

2012-2013

- ◆ Worked with team on the DARPA Robotics Challenge Track B “TROOPER” Team in cooperation with Lockheed Martin to simulate and deploy a humanoid rescue robot.
- ◆ Enabled walking and standing stability by implementing impedance control and ZMP algorithms in ROS using C++
- ◆ Assisted with the design and implementation of a machine learning/vision assignment to identify and grasp a hose.

Graduate Research Intern – Lockheed Martin Advanced Technology Center, Palo Alto, CA

2012

- ◆ Developed a MATLAB package which reduced digital noise and increased accuracy in laser simulations.
- ◆ Benchmarked a new high-performance computer (HPC) for radiative transfer plume analysis, and contributed to a real-time radiative transfer analysis Python program that increased the HPC efficiency by an order of magnitude.

Planetary Science Intern – NASA Jet Propulsion Laboratory, Pasadena, CA

2010

- ◆ Funded through the NASA Space Grant. Modeled radiative transfer in Titan’s detached haze layer in FORTRAN.
- ◆ Discovered and published on the rapid change in the altitude and eccentricity of Titan’s atmosphere over time.
- ◆ Published findings in *Geophysical Research Letters*

TEACHING EXPERIENCE

- CS6476: Computer Vision (Graduate)** – Georgia Institute of Technology 2017
- ◆ Held office hours and assisted in projects and grading.
- CS4641: Machine Learning** – Georgia Institute of Technology 2016
- ◆ Gave lectures, held office hours, and assisted in projects and grading.
- ESE-505: Introduction to Control Systems (Graduate)** – University of Pennsylvania 2013
- ◆ Assisted in lab formulation, oversight, and grading.
- MEAM-510: Mechatronic Systems (Graduate)** – University of Pennsylvania 2012
- ◆ Held office hours and assisted in labs and grading.
- PHYS-252: Intermediate Electricity and Magnetism** – Georgetown University 2010-2011
- ◆ For two semesters as head teaching assistant, lead labs, tutorials, and lectures, held office hours, and was responsible for grading.
- PHYS-101/102: Intro to Physics, Mechanics/Modern Physics** – Georgetown University 2009-2011
- ◆ For four semesters as TA, held office hours and assisted in labs, tutorials, and grading.

TECHNICAL SKILLS

Python, C++, PyTorch, OpenCV, LaTeX, ROS/Gazebo/RViz, Linux/bash, Caffe, TensorFlow, Boost, C, MATLAB, Arduino, PCL, OpenNI, Blender, GIMP/Inkscape, JAVA, XML, Windows Batch, Qt, Android, EJM, SolidWorks/OnShape, Mathematica

VOLUNTEER LEADERSHIP EXPERIENCE

- Vice President, RoboGrads Student Organization** – Georgia Institute of Technology 2012-2013
- ◆ Organized events to enable networking between students and professors interested in robotics and AI across multiple schools and disciplines
- FIRST Robotics Mentor** – Team 449, Montgomery Blair High School, MD 2014-2016
- ◆ Helped high school students understand engineering process using games played by robots built by the team. I have mainly helped the students understand and learn Java using the WPILib FRC Controls System, mentored the software team on how to debug their code.