

# Nathaniel J. S. Fairfield

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## Objective

I am looking for a robotics research position at a top-notch institution. My recent work is in simultaneous localization and mapping (SLAM) with sparse sensors in complex large-scale 3D environments. Other areas of experience and interest are in underwater robotics, science autonomy, and human-robot interaction.

## Education

Ph.D. Robotics, [Carnegie Mellon University](#), *expected* January 2009.

M.A. Robotics, [Carnegie Mellon University](#), June 2007.

B.A. Honors Major: Computer Science, Minor: Ancient Greek, [Swarthmore College](#), June 2001.  
*Magna Cum Laude*, Phi Beta Kappa, Sigma Xi.

[Universidad San Francisco de Quito](#), Ecuador, Brethren Colleges Abroad, junior year 1999-2000.

## Experience

### ROBOTICS INSTITUTE, CARNEGIE MELLON UNIVERSITY

Graduate student, advised by [David Wettergreen](#), 2004-Present. *My thesis research has focussed on localization and mapping in complex environments with a large variety of sensors and robotic systems.*

Lead software architect, [Google Lunar X-Prize](#), [Team Astrobotic](#), 2008-Present. *I have led a team of undergrads, graduate students, and staff to do rover software development, operator interface design, and field testing for CMU's high-stakes entry in the Google Lunar X-Prize.*

Graduate research, [Deep Phreatic Thermal Explorer \(DEPTHX\)](#), 2004-2008. *I primarily worked on 3D SLAM with sparse sonar sensors, but also did a lot of systems integration and testing, low-level drivers, and vehicle operations.*

Advisor for undergraduate research, ShallowX underwater robot, 2007-Present. *I have provided guidance and tutelage for undergraduates, with the project goal of autonomously tracking lines in a pool.*

Teaching assistant, Math Fundamentals for Robotics, Prof Michael Erdmann, 2005. I lectured on differential equations and numerical integration methods, designed homeworks, and graded them.

Co-organizer for 2006 & 2007 Robotics Immigration Course Competition for incoming PhD and Masters students. *We devised simple yet challenging tasks to be solved in one day by teams of new students using Lego Mindstorm kits.*

## PROFESSIONAL

Software engineer and vehicle operator, [Bluefin Robotics](#), 2001-2004. *Bluefin builds autonomous underwater vehicles (AUVs). I developed new robot framework software, GUI for operators, and many specialized device drivers (nav sensors, science sensors, sonars, acoustic modems), and led integration and training sessions for customers.*

Programmer, Fairfield Language Technologies (now [Rosetta Stone](#)), Summers 1998, 1999, 2000. *Rosetta Stone develops immersive language learning software. I streamlined the code base of the new release of The Rosetta Stone 2000, added features (UI and security) and then ported it to Shockwave for web use.*

## SWARTHMORE COLLEGE

Undergraduate Thesis: Simple Landmark Localization on a Three-Layer Mobile Robot Architecture

Robotics Summer Research with Bruce Maxwell and Lisa Meeden, Swarthmore College, 2000. *Worked on shared memory and socket communications, a reactive navigation system, and developed our low-level robot drivers and control architecture.*

## ROBOTIC SYSTEMS

CMU: Lunar Prototype 2. *A functional lunar rover prototype built using off-the-shelf parts that I have used to investigate flight-relevant questions about onboard software, operator interface with limited bandwidth, and operational procedures.*

CMU: Cave Crawler. *A second-generation mine mapping vehicle that uses spinning SICK lasers (see Groundhog below), I have used Cave Crawler to map and explore construction sites, parking garages, and tunnel systems, as well as used archived data from various coal mines.*

CMU: Groundhog. *A mine-mapping vehicle that uses nodding SICK lasers. While the vehicle was retired before my time, I have worked with many of its datasets from the Dakota and Mathies mines.*

Stone Aerospace: DEPTHX. *I was deeply involved in the development and deployment of the DEPTHX hovering AUV, which used an array of pencil-beam sonars and a suite of scientific sensors and sampling devices to autonomously map and characterize flooded sinkholes in Mexico.*

CMU: QuadRotor. *This small hovering aerial vehicle has an excellent horizontal laser scanner but an awful IMU. I have been working on localization in indoor environments using its datasets.*

MBARI: MBAUV. *I have demonstrated localization on the sea floor with datasets collected by the Monterey Bay Aquarium Research Institute's Multibeam Mapping AUV near Axial Seamount on the Juan de Fuca Ridge.*

CMU: BoatBot. *A solar-assisted robotic surface vessel that is in the very early stages of development.*

CMU: ShallowX. *A shallow-water hovering AUV that was constructed on a shoe-string by undergraduates, and I have worked with them to implement camera, IMU and depth sensor drivers, as well as dead-reckoning and control.*

Bluefin: 21" AUVs. *I worked on many different versions of Bluefin's standard vehicle, including vehicles with a wide range of scientific sensors, 3000 m depth rating, high grade IMUs, doppler velocity logs, acoustic modems, synthetic aperture sonars, sidescan sonars, subbottom profilers, and obstacle avoidance sonars.*

Bluefin: 9" & 12" AUVs. *These smaller AUVs were under development during my time at Bluefin, and were the first to use our new software architecture. I did extensive debugging, system characterization, and field testing for these new vehicles.*

Swarthmore: Magellan Pro. *I gained extensive experience with this small wheeled robot during undergraduate summer research in 2000 and my undergraduate thesis work.*

Miscellaneous: iRobot Create, Lego MindStorm, and MIT Handyboard. *Hours of fun!*

## FIELD EXPEDITIONS

Lunar X-Prize: Gascola slag heap 2008. *I led field trials at the Gascola slag heap, which provides an excellent lunar analogue.*

Lunar X-Prize: Robot City/LTV brownfield site 2008. *I led multiple lunar rover field testing and operator training sessions, including our first 500 m traverse with bandwidth-restricted communications.*

CMU: Panther Hollow Lake 2008. *I provided support and guidance during the lake tests of BoatBot.*

DEPTHX: Mexico 2007. *I primarily focussed on testing SLAM, but did a bit of everything on successive field expeditions to Mexico to explore, map, and scientifically characterize the cenotes of Sistema Zacatón.*

DEPTHX: Texas 2006. *Multiple trips to robot assembly at Stone Aerospace, tank testing facilities at UTexas Applied Research Labs, and field testing at a flooded quarry. I did system integration, low-level debugging, navigation and SLAM characterization, and operated the vehicle.*

DEPTHX: Mexico 2005. *Exploratory expedition to the site of Sistema Zacatón, during which we used a drop sonde to map the first few hundred meters of Zacatón. I did data processing and some of the inevitable debugging.*

Bluefin: United Kingdom 2004. *Two training and integration trips for a Synthetic Aperture Sonar AUV to QinetiQ testing facilities in Weymouth. I led the software-related training, did on-site integration, and was the only Bluefin representative during the second trip, which included a sea trial at Loch Ewe, Scotland.*

Bluefin: California 2003. *Multiple extended trips to testing facilities at the Monterey Bay Aquarium Research Institute, as well as sea trials of Bluefin's deep-rated vehicle aboard the R/V's Zephyr and Shana Rae. I was the senior software engineer and vehicle operator.*

Bluefin: Boston Harbor 2001-4. *I regularly ran R&D tests for new AUVs aboard the R/V Bluefin, as well as sea acceptance tests for customers.*

Bluefin: Woods Hole and Buzzards Bay 2001. *I helped with extensive acoustic characterization of a vehicle at Woods Hole Oceanographic Institute, and learned to do open-water operations and tune the vehicle's dynamic control.*

Bluefin: Greece 2001. *A joint archaeological expedition with MIT's AUV lab aboard the R/V AEGAEON that successfully located and imaged a classical wreck: my introduction to field expeditions and AUVs.*

## Conference Articles

N. Fairfield and D. Wettergreen. "Active Localization on the Ocean Floor With Multibeam Sonar," Proc. of MTS/IEEE OCEANS, 2008.

M. Gary, N. Fairfield, W.C. Stone, D. Wettergreen, G.A. Kantor, and J.M. Sharp Jr. "3D Mapping and Characterization of Sistema Zacatón from DEPTHX (DEep Phreatic THERmal eXplorer)," Proc. of KARST08: 11th Sinkhole Conference ASCE, 2008.

G.A. Kantor, N. Fairfield, D. Jonak, and D. Wettergreen. "Experiments in Navigation and Mapping with a Hovering AUV," Proc. of Intl. Conf. on Field and Service Robotics, 2007.

N. Fairfield, D. Jonak, G.A. Kantor, and D. Wettergreen. "Field Results of the Control, Navigation, and Mapping Systems of a Hovering AUV," Proc. of Intl. Symp. on Unmanned Untethered Submersible Technology, 2007.

N. Fairfield, G.A. Kantor, and D. Wettergreen. "Towards Particle Filter SLAM with Three Dimensional Evidence Grids in a Flooded Subterranean Environment," Proc. of ICRA, May, 2006.

N. Fairfield, G.A. Kantor, and D. Wettergreen. "Three Dimensional Evidence Grids for SLAM in Complex Underwater Environments," Proc. of UUST, August, 2005.

## Journal Articles

N. Fairfield, G.A. Kantor, and D. Wettergreen. "Real-Time SLAM with Octree Evidence Grids for Exploration in Underwater Tunnels," *Journal of Field Robotics*, 2007.

## Honors & Awards

Pennsylvania Space Grant Fellowship, 2005.

Member of Swarthmore robotics team, which won first place in the "Hors D'oeuvres Anyone?" and "Urban Search and Rescue" competitions, and the Ben Weigbret Award for Integrative Artificial Intelligence Technologies. AAAI conference, Austin, Texas, 2000.

Sigma Xi, Phi Beta Kappa.

IEEE Micromouse Competition: 1st Place, Philadelphia Section, 1999.

## Computer Systems

**Operating Systems:** *I have used, developed software for, and delved into the fundamentals of the following operating systems: Debian, Ubuntu, Redhat and associated variants of Linux; Mac OS X; QNX; Windows 2000.*

**Programming Languages:** *I tend to program in a mix of Matlab, Python, C++, and C, prototyping things in the higher-level languages before optimizing critical blocks of code. I have worked with large legacy systems in C, C++, and Java.*

**OpenGL:** *I have extensive data visualization experience with OpenGL, and have dabbled with early GPGPU techniques.*

**Software Development Tools:** *I administer several common software development tools, such as source control (CVS, SVN, BZR), issue tracking (Bugzilla), collaborative wiki sites (MoinMoin) and media archives (Gallery2).*

**Open Source Projects:** *I maintain the following open source projects:*

*SimpleIPC a simple messaging system designed for rapid deployment on robotic platforms. Based on the venerable Inter-Process Communication Package, simpleIPC offers several key extensions: units, auto-discovery, message descriptors, and a Python wrapper. Used on Lunar Prototype 2 and ShallowX.*

*Soto a graphical message debugger for simpleIPC. In addition to displaying the message traffic between processes, it can log and play back this traffic. Soto also provides the ability to design GUI "panels" that are populated with data from messages. Used on Lunar Prototype 2, ShallowX, and BoatBot.*

*Drake a 3D data visualization tool, specializing in the display of robotically collected point, range, and volumetric data. Provides a very flexible framework for different file formats and visualization parameters.*

## Personal

Dual American and Canadian citizen

International Experience: lived for about ten months each in France (1988-89), Nepal (1995-96), and Ecuador (1999-2000).

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