

# Michael Broxton

142 Acadia St. San Francisco, CA 94131  
(617) 461-4055 michael.broxton@nasa.gov

<b>Overview</b>	Michael Broxton is a research scientist in the Intelligent Robotics Group at NASA Ames Research Center where he specializes in computer vision and 3D surface reconstruction.
<b>Areas of Research</b>	Computer vision, 3D surface reconstruction, cartography, and robotics. Particular interest include multiple view geometry, stereogrammetry, photometry, state estimation, bundle adjustment, and robust statistical methods. Current academic focuses are stochastic signal processing, information theory, projective geometry, pattern recognition, classical and modern control theory, optimization methods, and numerical linear algebra.
<b>Education</b>	<p><b>Massachusetts Institute of Technology</b> ..... Fall 2003—Spring 2005 <i>M.E. in Electrical Engineering and Computer Science.</i></p> <p>Master's thesis: localizing wireless sensor nodes using ambient global sensor stimuli that occur naturally in the environment surrounding the sensor network rather than with a fixed infrastructure such as GPS.</p> <p><b>Massachusetts Institute of Technology</b> ..... Fall 1999—Spring 2003 <i>B.S. in Electrical Engineering and Computer Science.</i></p>
<b>Research Experience</b>	<p><b>Carnegie Mellon University / NASA Ames Research Center</b> ..... Moffett Field, CA <i>Intelligent Robotics Group</i> August 2005—current</p> <p>Modernized the <i>Ames Stereo Pipeline</i>; a software package for 3D surface reconstruction from stereo image pairs. Adapted the stereo pipeline to process stereo pairs from orbital camera platforms. Co-developed the <i>Vision Workbench</i>; a generalized C++ software library for large-scale image processing, mosaicking, interest point tracking, and stereo vision which was released under the NASA Open Source license in December 2006.</p> <p>Most recently: served as Principal Investigator of three core research projects in remote sensing, cartography, and computer vision. Raised approximately \$6 million over 3 years and led a team of ten researchers, software developers, and graduate students to significantly improved the state of the art in automated stereo reconstruction as part of NASA's Lunar Mapping and Modeling Project. Also led the NASA Planetary Content team that, in partnership with Google Inc., produced the Moon and Mars modes for Google Earth 5.0; thereby making NASA's planetary data sets easily &amp; universally available to the general public.</p> <p><b>MIT Media Laboratory – Responsive Environments Group</b> ..... Cambridge, MA <i>Advisor: Joseph Paradiso</i> September 2001—February 2005</p> <p>Designed and constructed the Pushpin Computer Network: a dense wireless sensor network with 50 sensor nodes. Wrote a library for reliable, ad hoc communications and routing between nodes and developed hardware and software infrastructure for efficiently programming, debugging, controlling, and querying Pushpin nodes. Master's thesis involved designing and characterizing a distributed localization system that leveraged shared knowledge of global sensor stimuli to determine the positions of nodes in three dimensional space. For details, refer to <a href="http://www.media.mit.edu/resenv/pushpin/">http://www.media.mit.edu/resenv/pushpin/</a></p> <p><b>Los Alamos National Laboratory – RADIANT Research Group</b> .... Los Alamos, NM <i>Advisor: Wu-chun Feng</i> June 2002—September 2002</p> <p>Created a kernel level environment for monitoring the network stack on Linux machines that participate as nodes in a distributed or grid computing environment. Custom plug-ins are supported that generate insightful, dynamic network statistics which provide real-time system feedback either locally or remotely.</p>
<b>Teaching Experience</b>	<p><b>MIT EECS Department</b> ..... Cambridge, MA</p> <p><i>Tau Beta Pi: Analog Circuits Tutorial, Instructor</i></p> <p>Designed and taught a three week review course on analog circuit design for a class of 25 students. Prepared teaching material including lecture notes and problem sets and presented a one hour daily lecture. (January 2004)</p>

- Awards & Achievements** NASA Ames Honor Award for developing Google Mars 3D (2009); J. Robert Oppenheimer Memorial Scholarship (1999); Los Alamos National Laboratory Foundation Scholarship (1999); admitted to Research Science Institute (RSI) at MIT in 1998.
- Talks & Presentations** **The Geospatial Data Revolution: Making Processed Lunar Data Universally and Easily Accessible.** Invited presentation given at the International Space University. 2009.  
**The NASA Vision Workbench: Reflections on Image Processing in C++.** Presented at Willow Garage. 2009.  
**Digital Techniques for Imaging & the Development of Lunar DEMs.** Invited presentation given at the *Go for Lunar Landing* conference in Tempe, AZ. 2008.
- Selected Publications** M. J. Broxton, A. V. Nefian, Z. Moratto, T. Kim, M. Lundy, and A. V. Segal. **3D Lunar Terrain Reconstruction from Apollo Images.** In *Proceedings of the 5th International Symposium on Visual Computing*. Las Vegas, NV. 2009.
- T. Kim, A. V. Nefian, and M. Broxton. **Photometric Recovery of Ortho-images Derived from Apollo 15 Metric Camera Imagery.** In *Proceedings of 5th International Symposium on Visual Computing*. 2009.
- A. Nefian, K. Husmann, M. Broxton, V. To, M. Lundy, M. Hancher. **A Bayesian Formulation for Sub-pixel Refinement in Stereo Orbital Imagery.** in *Proceedings of the 2009 IEEE International Conference on Image Processing*. 2009.
- M. Bualat, L. Edwards, T. Fong, M. Broxton, L. Flckiger, C. Kunz, S. Y. Lee, E. Park, V. To, H. Utz, V. Verma, M. MacMahon. **Autonomous Robotic Inspection for Lunar Surface Operations,** *Field and Service Robotics*, Volume 42/2008, pp. 169-178. 2008.
- L. Edwards and M. Broxton, **Automated 3D Surface Reconstruction from Orbital Imagery,** In *Proceedings of AIAA Space 2006*, San Jose, California, September 2006.
- M. Broxton, J. Lifton, and J. Paradiso. **Localization on the Pushpin Computing Sensor Network Using Spectral Graph Drawing and Mesh Relaxation..** *ACM Mobile Computing and Communications Review*, Volume 10, Issue 1. pp. 1 - 12. January 2006.
- M. Broxton. **Localization and Sensing Applications of the Pushpin Computing Network.** Master's Thesis, Massachusetts of Technology, 2005.
- J. Lifton, M. Broxton, and J. Paradiso. **Experiences and Directions in Pushpin Computing.** In *proceedings of the fourth international symposium on Information Processing in Sensor Networks (IPSN) 2005.* , pp. 416- 421. April 2005.
- M. Broxton, J. Lifton, and J. Paradiso. **Localizing a Sensor Network via Collaborative Processing of Global Stimuli.** In *Proceedings of the European Conference on Wireless Sensor Networks (EWSN) 2005*, Istanbul, Turkey, February 2005.
- M. Gardner, M. Broxton, A. Engelhart, and W. Feng. **MUSE: A Software Oscilloscope for Clusters and Grids.** In *17th IEEE International Parallel and Distributed Processing Symposium (IPDPS 2003)*, Nice, France, April 2003.
- M. J. Broxton, S. Backhaus, C.N. Ammerman, and R.A. Martin. **Simulation of an Acoustic Helmholtz Resonator using Computational Fluid Dynamics.** In *Proceedings of the American Society of Mechanical Engineers 2000 Fluids Engineering Division Summer Meeting*, Boston, Massachusetts, 2000.
- Interests & Activities** Explores fractals, chaos, and non-linear dynamics by writing GPU-accelerated video feedback software. Plays cello and guitar, and designs novel human interfaces for electronic music composition and performance. An avid photographer (<http://flickr.com/broxtronix>) and outdoors-person who rock climbs, caves, backpacks, swims, and practices breakdancing and Tae Kwon Do.