Uland Y. Wong, PhD

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OBJECTIVE

I am committed to create, grow and lead in developing next-generation robotic perception capabilities.

BIOGRAPHY

Dr. Uland Wong is a Senior Computer Scientist with SGT, Inc. at NASA's Ames Research Center. Dr. Wong is a member of the Intelligent Robotics Group, where his research pushes the limits of perception capability for planetary robots. Wong has a dozen years of experience leading robotics technology demonstrations and serves as an SGT Subject Matter Expert for computer vision. He is currently developing world-class expertise and facilities to characterize sensors for rover missions targeting the Lunar poles. He is also forging new directions in early stage robotics for exploration of extreme environments. Before moving to Ames, Wong was Senior Project Scientist at Carnegie Mellon's Robotics Institute, where he directed the Sensor Characterization Lab.

Dr. Wong has led projects supported by NASA, DOD, NSF and others. Within 2 years of earning his PhD, he had co-proposed and received more than $2.5 million in research funding. He is currently principal investigator on Smart Projectiles for Planetary Exploration (2017) and Automated Landing Site Selection for Icy Moons (2017). He has served as co-investigator and technical lead for Robotic Exploration of Planetary Skylights (2012), Non-Geometric Terrain Hazard Detection (2012) and Robotic Rescue Scout (2013) projects. As a graduate student, Wong successfully led Army (2010) and NIOSH (2011) contracts to comprehensively evaluate sensors for underground mapping.

Dr. Wong received his PhD degree in Robotics from CMU. In his thesis, Wong developed the idea of *Lumenhancement*, which explores how the interaction of light, materials and sensor fusion can be leveraged to model planetary surfaces. His work in generating super-resolution void models from image and LIDAR data by estimating light fields won the best student paper award at the premier conference for field robotics (FSR09). His *Tyrobot*, *Mosaic*, *Ferret*, and *Cavecrawler* robots have explored and operated in extreme spaces ranging from mines and caves to fractured planetary surfaces.

EXPERIENCE

Senior Computer Scientist IV, ***SGT Inc./NASA Ames***	**June 2015 –**
Senior Project Scientist, *Robotics Institute, CMU* Appointments: Senior Project Scientist (Dec 2013), Project Scientist (Sept 2012), Postdoctoral Fellow (May 2012)	May 2012 – Nov 2014
Graduate Research Assistant, *Robotics Institute, CMU*	Aug 2006 – April 2012
Student Researcher, *Field Robotics Center, CMU*	June 2004 – Dec 2005

EDUCATION

PhD in **Robotics,** Carnegie Mellon (2012)

- Dissertation titled "Lumenhancement: Exploiting Appearance for Planetary Modeling"
- Committee: William "Red" Whittaker (Chair), David Wettergreen, Srinivasa Narasimhan, Larry Matthies (NASA JPL)

MS in **Robotics,** Carnegie Mellon (2009)

MS in **Electrical and Computer Engineering,** Carnegie Mellon (2006)

- Simultaneously earned with Bachelor of Science

BS in **Electrical and Computer Engineering,** Carnegie Mellon (2006)

- University Honors (GPA)
- CIT Research Honors (Thesis)
- GPA: 3.94/4.0

RESEARCH THEMES

Active Illumination for Planetary Environments

Exploiting the physics of light transport is critical to the design and use of vision sensors and algorithms. My dissertation explored the use of targeted vision and illumination approaches (coined *Lumenhancement*) for perception. Intelligent use of active illumination or estimation of natural light fields can enhance image understanding. When coupled with appearance-constrained environments, such as dark planetary and underground spaces, image-based perception techniques gain significant effectiveness beyond non-contextual approaches. Generalization is achieved by grouping similar spaces into appearance domains. While demonstrated for a variety of planetary and underground environments, this approach is broadly applicable to other appearance classes like indoor and urban robotics. I have applied these principles to develop robots for mapping giant planetary sinkholes (i.e. *skylights*) and vision techniques for sun-following polar rovers.

Sensor Characterization

Many types of range and imaging sensors exist on the market. Manufacturer specifications are often non-comparable, collected in ideal settings, and ill-suited for robotics application. My research has developed characterization methodologies and sensor databases to provide a basis for empirical comparison of optical sensors. These tools are used as aids in the sensor selection process by comparing performance metrics like measurement distribution and accuracy. I created and led the Sensor Characterization Lab at CMU, which successfully fulfilled a DOD project and other funded work in this area. My lab released the world's first 3D robotics dataset for planetary pit analogs in 2014. I have continued this work at NASA Ames to develop the "Lunar Lab" with SSERVI. We are championing approaches to design and characterize rover navigation sensors at the Lunar poles and on airless bodies.

Multi-sensor Fusion for 3D Modeling

Current robotic maps are limited by decades-old range sensing technology. Only multi-sensor (LIDAR, camera, RADAR and multispectral) approaches can provide the density and quality of data required for automated inspection, operation and science. My research explores synergistic, multi-modal optical sensing to enhance understanding of geometry (super-resolution), sample locations of high information content (image-directed

scanning), and recover material properties from light source motion. Recently, we investigated multi-view tomography using phase-shift depth cameras for "seeing" through smoke and dust in underground rescue.

Novel Optical Sensors

I develop novel sensors for mapping and imaging. My image-directed structured light scanner optically co-located a high resolution camera with the output illumination of a DLP projector/camera using a half-silvered mirror. This configuration enabled hardware-supported intelligent sample selection with high resolution interpolation and texturing. During my thesis, I built a room-sized gonioreflectometer and planetary sun simulator without moving parts using an array of commodity SLR cameras and LED illumination. This design was capable of extracting BRDFs of planetary materials for graphical rendering at $1/100^{th}$ the cost of commercial spherical gantries. My *Ferret* borehole laser mapper (2006) and *Mosaic* panoramic imaging (2009) robots have mapped dozens of underground voids for the commercial mining industry. I am developing projectile sensors for modeling of dark caves and tunnels using structure-from-x motion.

SELECTED PUBLICATIONS

P.M. Furlong, M. Dille, U. Wong, A. Nefian. *Safeguarding a Lunar Rover with Wald's Sequential Probability Ratio Test*. In Proc. IEEE International Conference on Robotics and Automation (ICRA), 2016.

U. Wong and W.L. Whittaker. *Robotic Exploration and Science in Pits and Caves: Results from Three Years and Counting of Analog Field Experimentation*. 2nd International Planetary Caves Conference, 2015.

C. Cunningham, U. Wong, K. Peterson, W.L. Whittaker. *Predicting Terrain Traversability from Thermal Diffusivity*. International Conference on Field and Service Robotics (FSR), 2013.

A. Husain, H. Jones, B. Kannan, U. Wong, T. Pimentel Martins da Silva, S. Tang, S. Daftry, S. Huber, and W.L. Whittaker. *Mapping Planetary Caves with an Autonomous, Heterogeneous Robot Team*. IEEE Aerospace Conference, 2013.

U. Wong. *Lumenhancement: Exploiting Appearance for Planetary Modeling.* PhD Dissertation. Robotics Institute, Carnegie Mellon University, 2012.

U. Wong, B. Garney, C. Whittaker, W. Whittaker. *Image-Directed Sampling for Geometric Modeling of Lunar Terrain.* International Conference on Field and Service Robotics (FSR), 2012.

H.L. Jones, U. Wong, K. Peterson, J. Koenig, et al. *Complementary Flyover and Rover Sensing for Superior Modeling of Planetary Features.* International Conference on Field and Service Robotics (FSR), 2012.

U. Wong, A. Morris, C. Lea, J. Lee, C. Whittaker, B. Garney, W. Whittaker. *Comparative Evaluation of Range Sensing Technologies for Underground Void Modeling.* International Conference on Intelligent Robotics and Systems (IROS), 2011.

U. Wong, B. Garney, C. Whittaker, W. Whittaker. *Camera and LIDAR Fusion for Mapping of Actively Illuminated Subterranean Voids*. International Conference on Field and Service Robotics (FSR), 2009.

A. Morris, U. Wong, Z. Omohundro, C. Whittaker, W. Whittaker. *3D Modeling of*

Subterranean Environments by Robotic Survey. CMU Technical Report, 2007.

U. Wong, C. Lyons, S. Thayer. *An Analysis of the Human Odometer*. Tech. Report, CMU-RI-TR-05-47, Robotics Institute, Carnegie Mellon University, 2005.

[See website for complete bibliography]

HONORS AND AWARDS

Significant Contributions to Rover Software Development (SGT 2017)

Named as Subject Matter Expert for Computer Vision, 3D Sensing, and Sensor Characterization (SGT 2016)

Excellent Performance on Rover Software for RP Mission (SGT 2016)

NSF Travel Award (IROS 2011)

Best Student Paper, Int. Conf. on Field and Service Robots (FSR 2009)

Judge's Choice award for Human Odometer at Lockheed Martin/Eta Kappa Nu project competition (2006)

Edward J. Sargent scholarship for Electrical Engineering (2004-2005)

Member of Eta Kappa Nu honors society

Member of Tau Beta Pi honors society

Member of National Society of Collegiate Scholars

Dean's List Honors Fall 2002 – Fall 2003, Fall 2004 – May 2006

PROFESSIONAL SERVICE

Review Panelist, NASA Space Technology Mission Directorate

Chair, CMU Field Robotics Seminar Series (2012-2014)

Thesis Committee: James Lee (CMU MS, 2013)

Robotics Institute Graduate Admissions Committee

Robotics Institute Summer Research Experience for Undergrads (RISS) Mentor (2009-2013), 12+ students

Reviewer for IEEE ICRA, IEEE IROS, FSR, Journal of Field Robotics

TEACHING EXPERIENCE

Robotics 865, *Advanced Mobile Robot Design* Spring08, S09, S13

Graduate course to engineer robot prototype for the Google Lunar X-prize

- Taught lectures, designed curriculum, and managed student activities
- Ran large public demonstrations of robot and lunar technology (2009)

CS 212, *Principles of Programming Languages* Fall05, F06

Foundations class in language design, functional programming and semantics

- Taught recitations, led review sessions and developed assignments
- Responsible for the development of an interpreter for Standard ML and a compiler for music notation as class projects

SKILLS

I have extensive background in robotics, computer vision and fielded systems. I am proficient in programming Matlab, C/C++, and Standard ML with some prior experience in Visual Basic, Java, Scheme, Verilog, x86 and MIPS.

REFERENCES

[contact information for references available upon request]