

Henry Quach

Curriculum Vitae

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Education

- 2018–2022 **PhD, Optical Sciences and Engineering**, *University of Arizona, Wyant College of Optical Sciences, Tucson, AZ.*
Advisor: Dr. Daewook Kim
Dissertation Topic: *Deflectometry for Industrial Optics and Astronomical Reflectors*
- 2018–2020 **MS, Optical Sciences and Engineering**, *University of Arizona, Wyant College of Optical Sciences, Tucson, AZ.*
- 2013–2017 **BS, Mechanical Engineering**, *Duke University, Durham, NC.*
Advisor: Dr. Neal Simmons
Senior Capstone Design: *A Motorized Laparoscopic Cutter for Partial Nephrectomy*

Experience

Research Positions

- Aug 2018 **Graduate Research Associate**, *Large Optics Fabrication and Testing Group, Wyant College of Optical Sciences, Tucson, AZ.*
– Dec 2022
- I have been a member of the LOFT group for the past four years, researching and publishing on deflectometry, a non-null metrology method for measuring small to large optics with highly dynamic slopes. In this time, I have published 2 first-author journal papers (total with co-authorships: 9), and 5 first-author conference papers (total with co-authorships: 15).
- *My Research*: design, model, and test novel optical systems to measure highly sloped, rough, and freeform surfaces in industrial and astronomical optics.
 - *Active Experiments*: visible and LWIR deflectometry systems; shape measurement of inflatable telescope reflectors; polarization cues for optical metrology; optical alignment algorithms.
 - *What that usually entails*: synthesis and alignment of multi-DOF optical systems including: motion control, camera setup and calibration, illumination sources, and software written in Python or Matlab.
- Aug 2014 **Undergraduate Research Assistant**, *Brooke Research Group: Ocean Engineering and Conservation Robotics, Durham, NC.*
– May 2017
- *My Research*: Work on a variety of robotic underwater and aerial vehicles towards ocean conservation. We deployed a deep-ocean pH sensor off the coast of Monterey in 2014, and constructed a heavy-lift, hybrid unmanned aerial vehicle in 2017.
 - Developed a novel "differential Young's moduli" technique for waterproofing protruding wires at 3000 psi; successfully tested on a potted electronic speed controller at 3000 psi
 - Implemented a hybrid gas-electric power generation scheme to demonstrate that a mobile generator could meet the needs of a heavy-lift unmanned aerial vehicle (UAV).
 - Analyzed hydrostatic sensor device stresses and optimized underwater sensor body design for reliable durability at 1000 feet below the ocean surface.

Professional Positions

- May 2022 **Nikon Research Corporation of America**, *Optical Scientist Intern*, Oro Valley, AZ.
– Aug 2022
- Worked with principal optical scientists on new architectures in laser processing and optical metrology. Comprehensively applied lens design, radiometry, optomechanical engineering, and image processing.
 - Redesigned, built, and analyzed the performance of a multi-path, multi- λ (VIS, NIR, SWIR) imaging and illumination system in Zemax OpticStudio.
 - Calibrated and characterized high-speed (2k+ fps) imaging systems using oscilloscopes, resolution targets, integrating spheres, power meters, and a monochromator.
 - Completed academic literature and patent searches for open-ended, interdisciplinary concept ideation.
- May 2021 **Lawrence Livermore National Laboratory**, *Optical Engineering Intern*, Remote.
– Aug 2021
- Analyzed multiple-wavelength stray light and ghosts from a gigawatt laser system using FRED non-sequential raytracing software.
 - Optically modeled multiple-reflection, tip/tilt, defocus image sensitivity between beam-splitters, windows, lenses, mirrors, and prisms.
 - Wrote Matlab and SQL pipelines to unify laser shot data (calorimeters, pyrometers, and CMOS detectors) for temporal and spatial analyses.
- May 2017 **Intuitive Surgical**, *Mechanical Engineer, Instruments*, Sunnyvale, CA.
– Jul 2018
- Mechanical design and process engineering for complex robotic surgical instruments across da Vinci Xi and da Vinci SP product families.
 - Designed and implemented tooling for laser welding, pneumatic crimping, seal lubrication, and Instron testing, from machined parts designs and drawings through process qualification (IQ/OQ/PQ).
 - Coordinated with supplier, quality, and regulatory engineers to investigate, root-cause, and resolve defects in injection-molded and machined parts. Chassis, bearings, blades, seals, gears, wires, capstans!
- Aug 2015 **Innovation Co-Lab**, *3D Printing Studio Staff*, Durham, NC.
– May 2017
- Maintained, operated, and instructed others to use our lab's fleet of 45 Ultimaker FDM printers, Formlabs SLA printers, MarkForged Composite Printer (Nylon, Kevlar, Fiberglass), laser cutters, and ShopBot CNC.
 - Provided guidance in mechanical design, 3D modeling, digital fabrication, and open-source electronics to help troubleshoot and teach basic concepts of electronic prototyping with Arduino with a variety of sensors, motors, displays, and I/O's.
 - Taught others how to use the cloud printing workflow with 3DPrinterOS, as well as using specialty 3D printing software, such as simplify3D, Cura, and Mesh Mixer.
- May 2016 **Intuitive Surgical**, *Mechanical Engineering Intern, Advanced Product Development*, Sunnyvale, CA.
– Aug 2016
- Designed and executed experiments on manual laparoscopic instruments and da Vinci robotic instruments to explore new product requirements.
 - Interfaced parallel I/O ports with motor driver, implemented microstepping motor control, and wrote Python scripts to auto-generate movement routines.
 - Implemented precision machine design principles to design kinematic mounts for fixture modularity and process scalability.

- May 2015 **Oceaneering Space Systems**, *Spacesuit Engineering Intern*, Clear Lake, TX.
- Aug 2015
- Refined and tested the design of the suit controller of NASA's next-generation space suit, achieving an overall 7.6% product volume reduction.
 - Researched, selected, and procured space-grade pushbuttons, rotary switches, and flight connectors to increase thermal, shock, and dust resistance.
 - Authored and executed the suit controller (SCA) Test Readiness Review and the Suit Real Estate and Controls Usage Test Procedure.
 - Compiled hardware trade studies, 3D assemblies, and performance test data for Design Status Review presentation to NASA.

Knowledge and Skills

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| Technical Knowledge | Lens Design, Optical System Layout, Aberrations, Radiometry, Stray Light Analysis, Illumination Design, Polarization, Camera Calibration, Optical Alignment, Optical Shop Testing, Optomechanical Mounting |
| Optical S/W | Zemax OpticStudio, LightTools, FRED, Polaris-M |
| Optomech | Optical Alignment, Mount Design, Sensitivity Analysis, Error Budgeting |
| Mechanical | SolidWorks (Modeling + FEA), 3D Printing (SLA/FDM), CNC, Stepper Motor Control, Arduino and Electronic Breadboarding, Machine Design, Design for Manufacturing and Assembly |
| Metrology | Fizeau Interferometer, White Light Interferometer, CMM, Point Source Microscope, Laser Tracker, Confocal Microscope, Deflectometer |
| Programming | Matlab, Mathematica, SQL, Python with OpenCV |

Honors

- 2022 Selected Student Speaker, "10-Talk: The Theory (and Pragmatism) of Everything", Optica
- 2022 ARCS Foundation (Advancing Science in America Foundation) Scholarship
- 2022 Karlton Crabtree Memorial Scholarship in Optical Sciences
- 2021 Summer Slam Overall Winner, Lawrence Livermore National Laboratory
- 2021 Philip Slater Graduate Scholarship in Optical Sciences
- 2018 Roger Angel Graduate Scholarship in Optical Sciences
- 2017 Boeing K-12 Grand Challenges Program Fellowship
- 2017 Shell Ocean Discovery XPRIZE Semi-Finalist
- 2017 Invited Panelist, CTE Makeover Challenge Review, US Department of Education
- 2016 Finalist, Columbia Economics Review Environmental Policy Competition
- 2015 2nd Place, Conservation X Labs Case Competition
- 2015 Semi-Finalist, Wendy Schmidt Ocean Health XPRIZE
- 2014 3rd Place, ASCE Mead Paper on Professional Ethics
- 2013 Most Worthy Argonaut, Garden Grove High School
- 2013 Valedictorian, Garden Grove High School

Publications

Journal Papers (9)

- 2022 **H. Quach**, H. Kang, B. Jeong, H. Choi, D. Kim, "*Non-Planar Illumination Deflectometry for Axicon Metrology*," Optics Letters.
- 2022 S. Ordonez, J. Park, **H. Quach**, D. Kim, H. Choi, "*Spatial-temporal phase demodulation decoding superimposed ghost reflections in optical testing*," Optics Letters.
- 2022 S. Sirsi, **H. Quach**, H. Choi, D. Kim, Y. Takashima, C. Walker "*Modeling and Characterization of OASIS Inflatable Primary Antenna by Dual Modality Metrology*," Optics Express.
- 2022 **H. Quach**, H. Kang, S. Sirsi, A. Chandra, H. Choi, M. Esparza, K. Karrfalt, J. Berkson, Y. Takashima, A. Palisoc, J.W. Arenberg, C. Walker, C. d'Aubigny, D.W. Kim, "*Surface Measurement of a Large Inflatable Reflector in Cryogenic Vacuum*," Photonics.
- 2021 H. Kang, **H. Quach**, J. Berkson, M. Aftab, H. Choi, D.W. Kim "*Computational fiducial using G and C vector polynomials for alignment of deflectometry system*," Optics Letters.
- 2021 H. Kang, **H. Quach**, J. Berkson, M. Aftab, H. Choi, D.W. Kim "*Advances in Optical Engineering for Future Telescopes*," Opto-Electronic Advances.
- 2020 D.W. Kim, G. Smith, M. Dubin, A. Lowman, C.J. Oh, **H. Quach**, H. Kang, H. Yoo, I. Trumper, L.R. Graves, M. Aftab, C. Davila-Peralta, J. Hyatt, and H. Choi, "*Advances in reconfigurable optical metrology, characterization, and data analysis*," Journal of Physics: Photonics.
- 2019 L.R. Graves, **H. Quach**, R.J. Koshel, C.J. Oh, and D.W. Kim, "*High contrast thermal deflectometry using long-wave infrared time modulated integrating cavity source*," Optics Express.
- 2019 L.R. Graves, **H. Quach**, H. Choi, and D.W. Kim, "*Infinite deflectometry enabling 2π -steradian measurement range*," Optics Express.

Conference Papers (17)

- 2022 **H. Quach**, J. Berkson, H. Kang, H. Choi, and D.W. Kim, "*Influence of Lens and Perspective Distortion on Optical Surface Metrology Instrumentation*," Optical Manufacturing and Testing XIV.
- 2022 S. Sirsi et al., "*Orbiting Astronomical Satellite for Investigating Stellar Systems (OASIS): A Paradigm Shift in Realizing Large Space Telescopes*," Space Telescopes and Instrumentation: Optical, Infrared, and Millimeter Wave.
- 2021 D. Kim et al., "*Inflatable Space Terahertz Optics Technology*," Frontiers in Optics & Photonics.
- 2021 M. Esparza et al., "*Stressed Deformable Reflector and Pneumatic Membrane Antenna for Thermal Vacuum Terahertz Wavefront Control and Measurement*," Astronomical Optics, Design, Manufacturing, and Test of Space and Ground Systems III.

- 2021 A. Palosic et al., "Analytical and finite element analysis tool for nonlinear membrane antenna modeling for astronomical applications," *Astronomical Optics, Design, Manufacturing, and Test of Space and Ground Systems III*.
- 2021 **H. Quach**, M. Esparza, et al. , "Deflectometry-Based Thermal Vacuum Testing for a Pneumatic Terahertz Antenna," *Astronomical Optics, Design, Manufacturing, and Test of Space and Ground Systems III*.
- 2021 J. Berkson, Z. Hatfield, A. St. Peter, **H. Quach** , "Meter-Class Infrared Deflectometry for Visibly Non-Specular Surface Metrology," *OSA Optical Design and Fabrication Congress* .
- 2021 D.W. Kim, M. Esparza, **H. Quach**, S. Rodriguez, H. Kang, Y. Feng, and H. Choi,, "Optical Technology for Future Telescopes," *International Conference on Photonics and Optical Engineering*.
- 2021 **H. Quach**, H. Kang, H. Choi, D.W. Kim, "Non-Planar Illumination Sources for Deflectometry,," *Optical Manufacturing and Testing XIII*.
- 2021 **H. Quach**, J. Berkson, S. Sirsi, H. Choi, R. Dominguez, B. Duffy, D. Lesser, Y. Takashima, A. Palisoc, C. Walker, D.W. Kim.,, "Full-Aperture Optical Metrology for Inflatable Membrane Mirrors," *Optical Manufacturing and Testing XIII*.
- 2021 H. Kang, **H. Quach**, H. Choi, G. Smith, D.W. Kim, "Computational alignment of on-machine deflectometry," *Optical Manufacturing and Testing XIII*.
- 2020 D.W. Kim, C.K. Walker, D. Apai, T.D. Milster, Y. Takashima, R. Liang, et al. "Disruptive space telescope concepts, designs, and developments: OASIS and Nautilus," *EOSAM Frontiers in Optical Metrology*.
- 2020 **H. Quach**, L.R. Graves, H. Kang, D.W. Kim, "Electrically-Modulated optoelectronics-based infrared source enabling ground surface precision deflectometry," *Advances in Optoelectronic Technology and Industry Development*.
- 2020 D.W. Kim, M. Aftab, I. Trumper, L.R. Graves, **H. Quach**, H. Kang, H. Yoo, A. Lowman, G. Smith, M. Dubin, C.J. Oh, J. Hyatt, C. Davila-Peralta, H.J. Choi, "Reconfigurable dynamic optical system design, test, and data analysis, " *SPIE Photonics Europe*.
- 2019 D.W. Kim, M. Aftab, I. Trumper, L.R. Graves, **H. Quach**, H. Kang, X. Guo, and H. Choi, "Programmatic Large Precision Optics Manufacturing, " *International Conference on Optics and Electro-Optics* .
- 2015 M. Brooke et al. "An Ocean Sensor for Measuring the Seawater Electrochemical Response of 8 Metals Referenced to Zinc, for Determining Ocean pH. *IEEE 9th International Conference on Sensing Technology (ICST)*
- 2014 **H. Quach** and M. Shen " *Influence of Conformity on the Propagation of Alternative Tool Use Traditions in Chimpanzees (Pan troglodytes)*.

Leadership and Service

- 2022 **Ph.D. Qualifying Exam Review Instructor**, *Wyant College of Optical Sciences*. Led review sessions for the Ph.D. Qualifying Exam in hybrid format (lecture hall/zoom). Specialized in and created solutions for the Geometrical Optics section of the exam, including first-order optical system layout, imaging system properties, and raytracing.

- 2022 **Engineering Camp Volunteer**, *Wyant College of Optical Sciences*.
Helped 40 rising 10th-12th grade students debug and build various electronic Arduino projects, culminating in portable, handheld Infinity Mirrors.
- 2021 **Reviewer**, *Optica*.
- Present Peer review submitted manuscripts for the Optica Publishing Group journals, such as Optics Letters and Applied Optics. Subject matter expertise: optical metrology.
- 2022 **Invited Panelist**, *PRISM Week*, "Grad School Reflections".
Spoke and paneled at the WiO (Women in Optics) event, 'Grad School Reflections', to answer questions and give advice about I wish I knew earlier about grad school, personal growth in a Ph.D. program, and balancing general life with work.
- 2021 **Invited Panelist**, *PRISM Week*, "All Paths Lead to Optics".
Spoke and paneled at the WiO (Women in Optics) event, 'All Paths Lead to Optics', to discuss my identity as a first-generation college student and my journey into the field.
- 2020 **Graduate Mentor**, *Women in Optics*.
Mentored a 1st year graduate student in WiO's formal program for adjustment to the optic program, coursework advice, and research life.
- 2019 **Polarization Demo Creator**, *Optics Winter School*, Polarization.
Created linear and circular polarization demos for the inaugural class of selected undergraduate participants in the Wyant College of Optical Science's inaugural program.
- 2018 **Optics Outreach Volunteer**, *Wyant College of Optical Sciences*.
- 2022 Judged middle school and high school science fairs for SARSEF (Southern Arizona Research, Science and Engineering Foundation), gave demos on polarization, fluorescence, infrared imaging, and fiber optics at innumerable K-12 school science nights.
- 2018 **Robotics Competition Judge**, *MESA*.
Judged a high school robotics competition at Yerba Buena High School in San Jose, CA.
- 2017 **Boeing Fellow**, *Boeing Grand Challenges K-12 Program*.
Developed and taught curricula to local North Carolina K-12 schools, especially those interested in science, technology, and engineering.
- 2016-2017 **President**, *DukeMakers Club*.
President of the additive manufacturing student organization at Duke University, of 30 members. Oversaw and planned annual trips to the World Maker Faire in NY, pitched and fundraised for projects, and maintained the 3D printing workspace.
- 2015-2016 **Mechanical Design Lead**, *Duke Robotics Club*.
Led the mechanical design of an autonomous underwater vehicle for the annual collegiate AUUSI competition.

Professional Affiliations

- SPIE **Member**, Society of Photo Optical Engineers.
- OSA **Member**, Optical Society of America.
- ASPE **Member**, American Society of Precision Engineers.

Updated

December 2, 2022.