

TIMOTHY E. LEE

Principal Systems/Software Engineer, Robotics Institute, Carnegie Mellon University
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SUMMARY OF QUALIFICATIONS

- **Established record of leading the research and development of science and systems for robotics and unmanned platforms, specifically for mobile robotics, in academia and industry.** As Principal Systems/Software Engineer working under Prof. Nathan Michael, currently leading the development of a vision-based state estimation and localization technology used to track a submersible robot that conducts inspections of nuclear reactors. Technology was invented through M.S. in Robotics research at the Carnegie Mellon University (CMU) Robotics Institute. Technology is expected to be used in future nuclear reactor inspections. Prior industry experience as lead developer for an automated health monitoring flight software for a full-sized unmanned helicopter drone and a control system for an innovative helicopter actuator. Deeply passionate about inventing novel methodologies that yield intelligent automation technologies that improve society.
- **Diverse publication record that spans the disciplines of robotics science and unmanned systems.** Research experience has yielded 12 publications, including nine as first author. Most recently, research conducted as a Robotics Institute graduate student yielded three publications (including the *Field and Service Robotics 2017* conference) and two technology invention disclosures. Two journal publications in aerodynamics of vertical-lift platforms (such as robotic drones and quadrotors) conducted as a University of Maryland graduate student under renowned aerodynamicist Prof. J. Gordon Leishman achieved relatively large impact with 143 combined citations. Uniquely distinguished by conducting research at the world's leading institutions for robotics and computer science (CMU) and helicopters (Maryland).
- **Consistently recognized as a leader.** Recently selected as a Siebel Scholar as one of the top five CMU computer science graduate students in the 2017 graduating class for demonstrated scholastic, research, and leadership aptitude. Recognized as the top scholar-leader among A. James Clark School of Engineering senior undergraduates and the University of Maryland male senior undergraduates. Finalist for a prestigious national Leader of the Year award.

RESEARCH INTERESTS

I am deeply passionate about resilient artificial intelligence for mobile robots. Specifically, I seek multi-disciplinary methods towards enabling robots to abstract, reason, and learn online from novelties using contextually similar experience, while minimizing human intervention or domain-specific engineering approaches. To achieve this, I am interested in online algorithms and frameworks at the intersection of robotics science and artificial intelligence to enable experience-based learning, such as active perception and machine learning (specifically, transfer and reinforcement learning), for application to robotic perception, navigation, control, planning, and manipulation. Addressing the discrepancy between human and machine intelligence would unlock more efficient paradigms for developing robot autonomy, obviating the need for human experts that handcraft domain-specific algorithms if the robot itself can learn, adapt, and evolve from experience.

EDUCATION

M.S. in Robotics with Thesis, August 2017 August 2015 - August 2017
Carnegie Mellon University, Robotics Institute, School of Computer Science *Pittsburgh, PA*
Thesis Title: "State Estimation and Localization for ROV-Based Reactor Pressure Vessel Inspection Using a PTZ Camera"
Faculty Advisor: Prof. Nathan Michael
GPA: 4.05
Relevant Classes: *Statistical Techniques in Robotics; Artificial Intelligence: Planning, Learning, and Execution; Machine Learning; Mobile Robotics; Geometry-Based Methods in Vision; Kinematics, Dynamic Systems, and Control; Mathematical Fundamentals for Robotics.*

Artificial Intelligence Graduate Certificate, December 2014 June 2013 - December 2014
Stanford University, Computer Science Department via Stanford Center for Professional Development* *Stanford, CA*
Relevant Classes: *Artificial Intelligence: Principles and Techniques; Machine Learning; Computer Vision: From 3D Reconstruction to Recognition; Logic and Automated Reasoning.*
*Graduate Certificate completed while working full-time in industry.

M.S. in Aerospace Engineering with Thesis, December 2010 August 2007 - December 2010
University of Maryland, Department of Aerospace Engineering College Park, MD
Thesis Title: “Design and Performance of a Ducted Coaxial Rotor in Hover and Forward Flight”
Faculty Advisor: Prof. J. Gordon Leishman
GPA: 4.000
Relevant Classes: *Engineering Optimization; Computational Fluid Dynamics.*

B.S. in Aerospace Engineering with Honors in Aerospace Engineering, May 2007 Sept. 2003 - May 2007
University of Maryland, Department of Aerospace Engineering College Park, MD
Relevant Classes: *Flight Software Systems; Aerospace Computing; Control of Aerospace Systems; Dynamics of Aerospace Systems; Aircraft Flight Dynamics; Linear Algebra; Applied Probability and Statistics; Calculus I-III; Differential Equations.*

PUBLICATIONS

Master’s Theses:

- **T. E. Lee**, “State Estimation and Localization for ROV-Based Reactor Pressure Vessel Inspection Using a Pan-Tilt-Zoom Camera,” M.S. Thesis, Technical Report CMU-RI-TR-17-48, Robotics Institute, Carnegie Mellon University, August 2017. Graduate Advisor: Prof. Nathan Michael.
 - Web link: http://www.dropbox.com/s/upq61kiel7b297/telee_ms_thesis.pdf
- **T. E. Lee**, “Design and Performance of a Ducted Coaxial Rotor in Hover and Forward Flight,” M.S. Thesis, Department of Aerospace Engineering, University of Maryland, 2010. Graduate Advisor: Prof. J. Gordon Leishman.
 - Web link: <http://hdl.handle.net/1903/11300>

Journal Articles:

- **T. E. Lee**, J. G. Leishman, and M. Ramasamy, “Fluid Dynamics of Interacting Blade Tip Vortices With a Ground Plane,” *Journal of the American Helicopter Society*, Vol. 55, No. 2, pp. 022005-1 - 022005-16, April 2010.
 - *JAHS* is the premier academic journal for the helicopter technical community.
 - 82 citations.
 - Web link: <http://dx.doi.org/10.4050/JAHS.55.022005>
- M. Ramasamy, **T. E. Lee**, and J. G. Leishman, “Flowfield of a Rotating-Wing Micro Air Vehicle,” *AIAA Journal of Aircraft*, Vol. 44, No. 4, pp. 1236-1244, July 2007.
 - 61 citations.
 - Web link: <http://arc.aiaa.org/doi/pdf/10.2514/1.26415>

Conference Proceedings:

- **T. E. Lee** and N. Michael, “State Estimation and Localization for ROV-Based Reactor Pressure Vessel Inspection,” *Field and Service Robotics 2017*, Zurich, Switzerland, September 12-15, 2017.
 - Web link: http://www.fsr.ethz.ch/papers/FSR_2017_paper_72.pdf
- **T. E. Lee**, N. Michael, and L. J. Petrosky, “Autonomous Inspection of Nuclear Reactor Pressure Vessels via a Remotely Operated Vehicle,” *American Nuclear Society Decommissioning and Remote Systems 2016*, Pittsburgh, PA, July 31 - August 4, 2016.
- J. C. Krainski, B. C. H. Chu, and **T. E. Lee**, “A Review of Various GNC Design Strategies and Flight Test Results for Boeing Autonomous/Unmanned Rotorcraft and Their Applicability to Future Rotorcraft Platforms,” *2014 Boeing GNC8 Conference*, St. Louis, MO, October 14-16, 2014.
- **T. E. Lee**, M. J. Cribbs, and J. C. Krainski, “Automated, Integrated UAV Health Monitoring System: Flight Test Case Study,” *AHS Specialists’ Meeting on Unmanned Rotorcraft and Network Centric Operations*, Scottsdale, AZ, January 22-24, 2013.
- **T. E. Lee**, J. G. Leishman, and O. Rand, “Design and Testing of a Ducted Coaxial Rotor System for Application to an Unmanned Aerial Vehicle,” *66th Annual National Forum of the American Helicopter Society International*, Phoenix, AZ, May 11-13, 2010.

- **T. E. Lee**, J. G. Leishman, and M. Ramasamy, “Fluid Dynamics of Interacting Blade Tip Vortices With a Ground Plane,” *64th Annual National Forum of the American Helicopter Society International*, Montreal, Canada, April 29 - May 1, 2008.
- M. Ramasamy, J. G. Leishman, and **T. E. Lee**, “Flow Field of a Rotating-Wing Micro Air Vehicle,” *62nd Annual National Forum of the American Helicopter Society International*, Phoenix, AZ, May 9-11, 2006.

Newsletters:

- **T. E. Lee** and J. Svegliato, “Celebrating the Past, Present, and Future of Computing,” *AI Matters*, Vol. 3, Issue 3, Summer 2017, pp. 22-24, Association for Computing Machinery (SIGAI Chapter).
 - Web link: <http://dx.doi.org/10.1145/3137574.3137581>

RESEARCH EXPERIENCE

Graduate Research Assistant

September 2015 - present
Pittsburgh, PA

Carnegie Mellon University, Robotics Institute

- As member of Prof. Nathan Michael’s Resilient Intelligent Systems Lab, invented and developed a vision-based tracking system (“ROV Tracker”) for a submersible robot that conducts inspection of underwater critical infrastructure, such as nuclear reactor pressure vessels. The ROV Tracker, which leverages a pan-tilt-zoom (PTZ) camera, is the fundamental state estimation and localization system that will enable automated infrastructure inspection of nuclear reactors. Technology invention efforts spanned both software/algorithm and hardware domains, including the design of an underwater housing for an off-the-shelf PTZ camera.
- Developed and tested real-time, robust perception and localization capabilities in C++ using the Robot Operating System (ROS) architecture and leveraging the Eigen and OpenCV open-source libraries. Capabilities are based on validated prototype algorithms, enabling field inspection deployments with the robot. Representative capabilities include fiducial marker detection and tracking, automated control of a PTZ camera via visual servoing, reactor landmark detection and association with respect to a reactor map, online system initialization using camera self-calibration from structure, system fault detection and recovery, and the underlying state estimation framework of an extended Kalman filter (EKF).
- Developed system simulation that models the vision-based perception system, robot dynamics, trajectory generation, vehicle control system, and infrastructure geometry. Simulator generates high-fidelity synthetic camera images to enable prototyping of perception and estimation algorithms.
- Conducted many camera and platform experiments to quantify perception and localization algorithm performance with a variety of vision-based modalities (e.g., stereo cameras, monocular camera, PTZ camera).
- Contributed to the development of a dense mapping framework utilizing stereo cameras (C++/ROS).
- Graduate research yielded three academic publications and two technology invention disclosures.

Glenn L. Martin Graduate Assistantship/Graduate Research Assistant

August 2007 - November 2009
College Park, MD

University of Maryland, Department of Aerospace Engineering

- Conducted graduate thesis research in the design, test, and evaluation of a ducted coaxial rotor unmanned aerial vehicle (UAV) platform. Designed and constructed 14” diameter UAV, duct, and test stand. Integrated various sensing (rotor speed, thrust, torque) and data acquisition capabilities with the system. Quantified UAV performance in hover and forward flight by conducting wind tunnel experiments for various hardware configurations.
- Graduate research in aerodynamics for application to unmanned aerial vehicles yielded four academic publications.

Minta Martin Intern (Undergraduate Research Intern)

June 2005 - August 2007
College Park, MD

University of Maryland, Department of Aerospace Engineering

- Conducted experimental research in rotating-wing aerodynamics for miniature-scale unmanned aerial platforms (micro-air vehicles [MAV]). Designed and constructed MAV (approx. 6” diameter). Quantified MAV thrust and torque performance.
- Undergraduate research resulted in two academic publications.

PROFESSIONAL EXPERIENCE

Carnegie Mellon University: The Robotics Institute

August 2017 - present

Principal Systems/Software Engineer

Pittsburgh, PA

- Continuing research and development of the ROV Tracker system with Prof. Nathan Michael to transition the technology from a viable prototype to an intelligent, commercial-grade system that succeeds in nuclear reactor inspections with minimal operator inputs.
- Current efforts include robustification of vision-based perception and state estimation algorithms and extensive field testing with an underwater mockup of a nuclear reactor.

The Boeing Company: Boeing Research and Technology

January 2013 - January 2015

Control Systems Engineer

Huntington Beach, CA

· **Controller Lead Engineer for Electric Helicopter Actuator Research Program**

- Validated developmental three-phase electric motor control software designed using Simulink Embedded Coder, which generates embedded C code for a 32-bit Texas Instruments microcontroller.
 - Validation consisted of developing software improvements, software and hardware debugging, motor performance testing in a laboratory environment, documenting software and test results, and developing operations procedures.
 - Successful customer demonstration of motor control software in June 2013 lead to funding capture, allowing actuator development work to continue.
- Designed preliminary electric actuator control laws from existing three-phase electric motor control laws by incorporating various sensors (e.g., LVDT, resolver) and position control algorithms.
- Developed simulation of electric actuator system using Simulink. Developed models of constituent mechanical and electrical components (e.g., gearbox, electric motor) from technical datasheets.
- Developed simulation of a vehicle hybrid power system using Simulink, including control law design for power management based on vehicle load demand using proportional-integral-derivative (PID) control with a state machine.

The Boeing Company: A160 Unmanned Helicopter Program

November 2009 - December 2012

Data and Software Systems Engineer

Irvine & Huntington Beach, CA

· **Autonomous Health Monitoring System (“HealthMon”) Flight Software Lead Developer**

- HealthMon software suite consisted of on-vehicle embedded software (C++) that analyzed telemetry in real-time for faults and other noteworthy events, two Windows programs (C++/MFC) usable by flight test personnel to view detected events, and post-processing MATLAB tools, with the objective of reducing the personnel footprint required to conduct vehicle testing and to expedite the approval of vehicle health for further tests.
- Inherited responsibilities of project lead following initial software design phase in Spring 2011, with focus on leading the software’s maturation from a developmental tool to a deployable program asset.
- Scope of work encompassed entire software lifecycle, from design and development to test (including unit, integration, and regression testing in flight computer test network) and analysis.
- Established software release processes and quality enforcement, such as establishing software acceptance tests, preparing release information, managing builds, utilizing revision control tools, and tracking issues.
- Conducted telemetry data analysis to characterize vehicle health trends, faults, and states.
- HealthMon system detected over 250 health events and accumulated over 200 engine hours and over 50 flight hours, with positive feedback from flight test personnel. Summary conference paper was presented in January 2013.
- Identified, characterized, and proposed resolutions for suboptimal performance of aircraft autonomy found during flight test by conducting analyses of telemetry and flight software. Examples include analysis of the aircraft fuel manager, on-ground detection algorithm, wind estimation algorithm, and autorotation algorithm.
- Developed automated data analysis algorithms in MATLAB to mine nearly one terabyte of A160 flight data in order to aid in the characterization of fleet-wide aircraft critical parameters.
- Contributed to program-critical reviews and Root Cause and Corrective Action analyses as flight data representative.

AWARDS AND ACCOLADES

Professional Recognition:

- Promoted to Engineer 3 in recognition of effectiveness and impact on the Boeing A160 program (The Boeing Company: April 2012).
- Received six peer-nominated recognition awards (Pride@Boeing) for outstanding job performance and program impact (The Boeing Company: March 2012, April 2012, October 2012, July 2013, May 2014 (2x)).

Collegiate Awards:

- **ACM SIGAI Student Scholar** (ACM Special Interest Group on Artificial Intelligence (SIGAI): Summer 2017)
 - Selected as one of two graduate students to represent SIGAI at the Association for Computing Machinery’s *Celebration of 50 Years of the A.M. Turing Award* in San Francisco, CA, June 23-24, 2017.
- **Siebel Scholar in Computer Science** (Siebel Scholars Foundation and CMU School of Comp. Sci.: Fall 2016)
 - Awarded to the top 5 CMU computer science graduate students in the 2017 class based on academics, research, leadership, and capability for enacting meaningful change.
 - Award carried a fellowship of \$35,000 to support graduate studies.
 - Siebel Scholars class represents nearly 100 graduate students selected from the world’s leading institutions.
- **A. James Clark School of Engineering Dean’s Award** (A. James Clark School of Engineering: Spring 2007)
 - Represents the most prestigious award for a senior engineering undergraduate who has “demonstrated scholastic excellence, outstanding service, and outstanding leadership to the Clark School of Engineering.”
- **President Emeritus H. C. Byrd Citizenship Prize** (University of Maryland: Spring 2007)
 - Represents the most prestigious University award for a senior male scholar-leader who has “typified the model citizen and has contributed significantly to the general advancement of the interests of the University.”
- **General Russell E. Dougherty National Leader of the Year Finalist** (Omicron Delta Kappa: Spring 2007)
 - Recognizes the most influential “leader among leaders” of all Omicron Delta Kappa chapters in the nation. One of four finalists that each was selected Leader of the Year for their local chapter and chapter’s region.
- Outstanding Ambassador Award (A. James Clark School of Engineering: Spring 2007)
- Spirit of Maryland Award (University of Maryland: Fall 2006)
 - Recognizes a member of the senior undergraduate class who has demonstrated “outstanding scholarship, leadership, campus involvement, community service, and communication skills.”
- Student Honor Award (University of Maryland Alumni Association, Engineering Chapter: Spring 2006)
 - Recognizes an engineering undergraduate “who has shown keen interest, development, and accomplishment in leadership, academics, teamwork, and active participation in student engineering organizations.”
- Patricia Mielke Citizenship Award (College Park Scholars: Fall 2005)
- Dean’s Award for Academic Excellence (College Park Scholars: Fall 2005)

Academic Honors and Honor Societies:

- Aerospace Engineering Honors Program
- Tau Beta Pi, the National Engineering Honor Society
- Omicron Delta Kappa, the National Leadership Honor Society
- Sigma Gamma Tau, the National Honor Society in Aerospace Engineering
- National Residence Hall Honorary (Top 1% of On-Campus Leaders)
- Primannum Honor Society (Alpha Lambda Delta and Phi Eta Sigma)
- College Park Scholars Citation in “Science, Discovery, and the Universe”

Academic Assistantships and Scholarships:

- Graduate Research Assistantship (Department of Aerospace Engineering: Fall 2008-Fall 2009)
- Glenn L. Martin Graduate Assistantship, a half-fellowship, half-research assistantship (Department of Aerospace Engineering: Fall 2007-Fall 2008)
- Vertical Flight Foundation Scholarship (American Helicopter Society International: Spring 2008)

- Young Alumni Club Scholarship (University of Maryland Alumni Association: Fall 2008)
- Chuck and Judy Sturtz Leadership Scholarship (University of Maryland: Spring 2007)
- Clark School Ambassadors Scholarship (A. James Clark School of Engineering: Spring 2005-Spring 2007)
- Glenn L. Martin Scholarship (Department of Aerospace Engineering: Fall 2005-Fall 2006)
- Aerospace Engineering Scholarship (Department of Aerospace Engineering: Fall 2004-Spring 2005)
- William J. Higgins New Member Scholarship (Primannum Honor Society: Spring 2004)

TECHNICAL SKILLS

Programming Languages	C++, Python, MATLAB
Software Tools	Robot Operating System (ROS), Eigen, OpenCV, Git, MATLAB/Simulink, L ^A T _E X
Platforms	Linux (Ubuntu), Windows, VxWorks

SERVICE AND LEADERSHIP ACTIVITIES

Field Robotics Center (FRC) and Robotics Institute community:

- Led the data recovery effort as a member of the FRC Computing Committee for three NetApp servers used for the DARPA Urban Challenge. Starting from little previous knowledge of the servers, worked with NetApp server experts to recover access to these servers to characterize contents and importance of server data. (Spring 2016)
- Contributed to clean-up efforts for the NSH high bay laboratory. (Fall 2015)

Maryland education and scientific community:

- Chaperone/tutor for Glenallan Elementary School students visiting the Maryland Science Center in Baltimore, MD. (Spring 2015)

A. James Clark School of Engineering community:

- Team Leader for the University of Maryland's graduate submission to the 2012 AHS Student Design Competition. Led team to a second-place finish. ("Helicopter Design": Spring 2008)
- Tau Beta Pi (President: Fall 2006-Spring 2007, Induction Chair: Spring 2006)
- Student recruiter for the A. James Clark School of Engineering through the Clark School Ambassadors program (Special Programs Coordinator: Spring 2007, Founding Member)
- Teaching Fellow for "Introduction to Engineering Design" (Spring 2007)
- Engineering Student Council (Secretary: Fall 2004)

University of Maryland community:

- Omicron Delta Kappa (Webmaster: Spring 2008, Newsletter Editor and Ritualist: Fall 2006-Spring 2007)
- Resident Assistant - 20 hours per week commitment (Spring 2005-Spring 2006)
- Teaching Assistant for "Introduction to Student Personnel" (Spring 2006)
- Orientation Advisor - worked primarily with incoming engineering students (Summer 2004)

TEACHING EXPERIENCE

Teaching Fellow for "Introduction to Engineering Design" January 2007 - May 2007
University of Maryland, A. James Clark School of Engineering College Park, MD

- Assisted with lectures with instructor to promote understanding of engineering fundamentals for 38 students enrolled in "Introduction to Engineering Design," the first-year engineering class.

Teaching Assistant for "Introduction to Student Personnel" January 2006 - May 2006
University of Maryland, Department of Resident Life College Park, MD

- Led recitation sections with two co-instructors for 20 students enrolled in "Introduction to Student Personnel," the training class for Resident Assistants.
- Facilitated discussion of student personnel topics, including significance of community development, diversity, leadership behaviors, conflict management, and peer mediation.

PROFESSIONAL AFFILIATIONS

- American Institute of Aeronautics and Astronautics (AIAA)
 - Senior Member
- Association for the Advancement of Artificial Intelligence (AAAI)
- Association for Computing Machinery (ACM)
 - Special Interest Group on Artificial Intelligence (SIGAI)
- Association for Unmanned Vehicle Systems International (AUVSI)
- Institute of Electrical and Electronics Engineers (IEEE)
 - Robotics and Automation Society (RAS)