

KEENAN ALBEE

robotics.jpl.nasa.gov/who-we-are/people/keenan-albee

EMPLOYMENT

NASA Jet Propulsion Lab, Maritime and Multi-Agent AutonomyPasadena, CA
Robotics Technologist Aug. 2022 – Present

- Serve on the GNC and autonomy teams for the CADRE lunar technology demonstration mission, a set of three fully autonomous lunar rovers running a modern robotics autonomy stack.
- Designing, implementing, and verifying multi-agent distributed leader election, real-time optimization-based motion planning, and other algorithms for CADRE.
 - Work will include the first trajectory optimization approach to run on another celestial body.
- Engage with academia and pursue research in the areas of multi-agent robotic planning, control, coordination, and estimation, including multiple funded internal and external research proposals.

EDUCATION

Massachusetts Institute of Technology Cambridge, MA

· Ph.D. in Aeronautics and Astronautics May 2022

Field: Autonomous Systems (*major*), Numerical Methods (*minor*)

Thesis: “Online Information-Aware Motion Planning with Model Improvement for Uncertain Mobile Robotics”

Thesis Committee: Dr. David W. Miller (*chair, advisor*), Dr. Richard Linares, Dr. Nicholas Roy, Dr. Zachary Manchester (*reader*), Dr. Christopher Jewison (*reader*)

· S.M. in Aeronautics and Astronautics May 2019

Thesis: “Toward Optimal Motion Planning for Dynamic Robots: Applications On-Orbit”

Columbia UniversityNew York, NY

· B.S. in Mechanical Engineering May 2017

Minors: Computer Science, History

RESEARCH INTERESTS

Extreme environment robotics, planning/control under uncertainty, novel aerospace systems

- Developing robotics algorithms for resource-constrained systems that handle model uncertainty with safety-awareness. Emphasis on field deployment, with a deep understanding of the constraints of real aerospace robotics platforms, spanning microgravity to planetary exploration.
- Enabling planning, control, and coordination for systems that are dynamics-rich, multi-agent, and information-seeking. Online model learning and control adaptation to online-learned information.
- Gracefully combining learning-based tools, analytical optimal control, trajectory optimization, and robotic motion planning to speed up computation and handle model, environmental, and estimation uncertainties, with emphasis on scenarios relevant to novel aerospace robotic and exploration systems.

JOURNAL PUBLICATIONS

- J6. P. Roque, **K. Albee**, A. Rahmani, D. Dimarogonas, “Adaptive Corridor MPC: Optimal and Safe Trajectory Tracking with Online Estimation,” *IEEE Transactions on Automatic Control*. (In preparation.)
- J5. H. Dinkel, J. Di, J. Santos, **K. Albee**, et al., “AstrobeeCD: Change Detection in Microgravity with Free-Flying Robots,” *Acta Astronautica*, 2024.
- J4. **Bryce Doerr and K. Albee and M. Ekal**¹, et al., “The ReSWARM Microgravity Flight Experiments: Planning, Control, and Model Estimation for On-Orbit Close Proximity Operations,” *Journal of Field Robotics*, 2024.
- J3. **K. Albee and M. Ekal**, et al., “The RATTLE Motion Planning Algorithm for Robust Online Parametric Model Improvement with On-Orbit Validation,” *Robotics and Automation, Letters*, 2022.²
- J2. **K. Albee**, et al., “A Robust Observation, Planning, and Control Pipeline for Autonomous Rendezvous with Tumbling Targets,” *Frontiers in Robotics and AI*, vol. 8, p. 234, 2021.
- J1. H. Zhang, **K. Albee**, and S. K. Agrawal, “A Spring-Loaded Compliant Neck Brace with Adjustable Supports,” *Mechanism and Machine Theory*, vol. 125, pp. 34–44, 2018.

CONFERENCE PUBLICATIONS

- C16. M. Iversflaten, A. Hansson, **K. Albee**, “Robust Replanning for Multi-Agent SmallSat Inspection in Failure Scenarios,” *AIAA SciTech*, Orlando, FL, 2025. (Accepted, in preparation.)
- C15. **K. Albee**, D. Sternberg, A. Hansson, D. Schwartz, R. Majumdar, O. Jia-Richards, “Architecting Autonomy for Safe Microgravity Free-Flyer Inspection,” *IEEE Aerospace Conference*, Big Sky, MT, 2025. (In review.)
- C14. J.P. de la Croix, F. Rossi, R. Brockers, D. Aguilar, **K. Albee**, et al., “Multi-Agent Autonomy for Space Exploration on the CADRE Lunar Technology Demonstration Mission,” *IEEE Aerospace Conference*, Big Sky, MT, 2024.
- C13. H. Dinkel, J. Di, J. Santos, **K. Albee**, et al., “Multi-Agent 3D Map Reconstruction and Change Detection in Microgravity with Free-Flying Robots,” *International Astronautical Congress (IAC)*, Baku, Azerbaijan, 2023.
- C12. **K. Albee**, C. Specht, H. Mishra, C. Oestreich, B. Brunner, R. Lampariello, “Autonomous Rendezvous with an Uncertain, Uncooperative Tumbling Target: The TumbleDock Flight Experiments,” *ESA Advanced Space Technologies in Robotics and Automation (ASTRA)*, Noordwijk, Netherlands, 2022.
- C11. W. Parker, **K. Albee**, and R. Linares, “Spacecraft Dynamics Model Learning and Control with Gaussian Process Regression,” *AAS/AIAA Astrodynamics Specialist Conference*, Big Sky, MT (Virtual), 2021.
- C10. **M. Ekal and K. Albee**, B. Coltin, R. Ventura, R. Linares, and D. W. Miller, “Online Information-Aware Motion Planning with Inertial Parameter Learning for Robotic Free-Flyers,” *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Prague, Czech Republic (Virtual), 2021.

¹Bolded “and” denotes equal contribution.

²Also accepted and presented at *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Kyoto, Japan, 2022.

- C9. B. Doerr, **K. Albee**, M. Ekal, R. Linares, and R. Ventura, “Safe and Uncertainty-Aware Robotic Motion Planning Techniques for Agile On-Orbit Assembly,” *AAS/AIAA Astrodynamics Specialist Conference*, Big Sky, MT (Virtual), 2021.
- C8. C. Oestreich, A. Teran, J. Todd, **K. Albee**, and R. Linares, “On-Orbit Inspection of an Unknown, Tumbling Target using NASA’s Astrobeer Robotic Free-Flyers,” *Conference on Computer Vision and Pattern Recognition*, (Virtual), 2021.
- C7. **K. Albee and A. C. Hernandez**, “The Case for Parameter-Aware Control of Assistive Free-Flyers,” *AIAA SciTech GNC*, Nashville, TN (Virtual), 2021.
- C6. **K. Albee**, A. C. Hernandez, O. Jia-Richards, and A. Teran, “Real-time Motion Planning in Unknown Environments for Legged Robotic Planetary Exploration,” *IEEE Aerospace Conference*, Big Sky, MT, 2020.
- C5. A. Teran, H. Hettrick, **K. Albee**, A. C. Hernandez, and R. Linares, “End-to-End Framework for Close Proximity In-Space Robotic Missions,” *International Astronautical Congress (IAC)*, Washington, D.C., 2019.
- C4. W. D. Sanchez, **K. Albee**, R. Davidson, R. de Freitas Bart, A. Cabrales Hernandez, and J. Hoffman, “A Preliminary Architecture Optimization for In-Space Assembled Telescopes,” *International Astronautical Congress (IAC)*, Washington, D.C., 2019.
- C3. **K. Albee and M. Ekal**, R. Ventura, and R. Linares, “Combining Parameter Identification and Trajectory Optimization: Real-Time Planning for Information Gain,” *ESA Advanced Space Technologies for Robotics and Automation (ASTRA)*, Noordwijk, The Netherlands, 2019.
- C2. **K. Albee**, A. Teran, N. Werner, H. Chen, K. Andreyeva, and T. Sarvary, “Motion Planning for Climbing Mobility with Implementation on a Wall-Climbing Robot,” *IEEE Aerospace Conference*, Big Sky, MT, 2019.
- C1. H. Hall, B. Donitz, D. Srivastava, **K. Albee**, et al., “Project Zephyrus: Developing a Rapidly Reusable High-Altitude Flight Test Platform,” *IEEE Aerospace Conference*, Big Sky, MT, 2018.

WORKSHOP PUBLICATIONS

- W4. **K. Albee**, S. Bhamidipati, F. Rossi, J. Vander Hook, J.P. de la Croix, “Lunar Leader: Persistent, Optimal Leader Election for Multi-Agent Exploration Teams,” *International Workshop on Autonomous Agents and Multi-Agent Systems for Space Applications (MASSpace) at AAMAS*, Auckland, New Zealand, 2024.
- W3. J.P. de la Croix, F. Rossi, Y. Kumar, **K. Albee**, “Using OpenCL to Speed Up Parallelizable Autonomy Algorithms on CADRE,” *The 2023 Flight Software Workshop*, Pasadena, California, 2023.
- W2. **M. Ekal and K. Albee**, B. Coltin, R. Ventura, R. Linares, and D. W. Miller, “Model Predictive Control and Integration with the Autonomy Stack of the Astrobeer Free-Flyer,” *International Symposium on Artificial Intelligence, Robotics and Automation in Space (iSAIRAS)*, Pasadena, California (Virtual), 2020.
- W1. **K. Albee** and B. Coltin, “Kinodynamic-RRT for Robotic Free-Flyers: Generating Feasible Trajectories for On-orbit Mobile Manipulation,” *International Conference in Robotics and Automation (ICRA) Workshop: Toward Online Optimal Control of Dynamic Robots*, Montreal, Canada, 2019.

TEACHING EXPERIENCE

Teaching

- Guest Lecturer: “Autonomous On-Orbit Rendezvous with Tumbling Targets,” KTH Royal Institute of Technology, Stockholm, Sweden (Virtual), Oct. 2022.
- Teaching Assistant: Dynamics (16.07), Massachusetts Institute of Technology, Fall 2017 and Fall 2019. Duties included exam, problem set, and project preparation and grading, holding biweekly office hours, and teaching multiple recitation and special lecture presentation sections.

Mentorship

Ph.D. and master’s students

- David Schwartz (ETH Zürich), *JPL Visiting Student Researcher Program (JVSRP)* mentor, Summer 2024 - Fall 2024.
- Alex Hansson (ETH Zürich), *JPL Visiting Student Researcher Program (JVSRP)* mentor and SM advisor, Spring 2024 - Fall 2024.
- Ritwik Majumdar (UMich), *JPL Summer Internship Program (SIP)* mentor, Summer 2024.
- Markus Iversflaten (NTNU), *JPL Visiting Student Researcher Program (JVSRP)* mentor, Spring 2024.
- Pedro Roque (KTH), *JPL Visiting Student Researcher Program (JVSRP)* mentor, Fall 2023.
- Charles Oestreich, Nick Parker, Allegra Farrar (MIT), Advisor: Dr. Richard Linares, Fall 2019 - Spring 2021.

Undergraduate students

- Michael Schwarz (University of Montana), *JPL Year-round Internship Program (YIP)* mentor, Summer 2023.
- Ian Hokaj, Phillip Johnson (MIT), *Undergraduate Research Opportunity Program (UROP)* mentor, Fall 2020 - Spring 2021.

Misc.

- Reviewer/Mentor: *NASA Community College Aerospace Scholars Program*, Mar. 2023.

ACADEMIC SERVICE

Conference service

- Session Chair, Space Robotics and Automation, *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2021.

Proposal reviews

- Subject Matter Expert Proposal Reviewer (2-day panel), *Lunar Surface Technology Research (LuSTR): Robotic Wheeled Mobility*, NASA STMD, 2023.

Journal reviews

- *IEEE Robotics and Automation Magazine*, 2023.
- *Journal of Spacecraft and Rockets*, 2023.
- *The Journal of the Astronautical Sciences*, 2022.
- *Robotics and Automation, Letters*, 2022.
- *Journal of Guidance, Dynamics, and Control*, 2022.

Conference reviews

- *International Conference in Robotics and Automation (ICRA)*, 2021-2024.

Thesis committees

- Sydney Dolan (MIT), *Ph.D. thesis reader*, 2024.

TALKS, PRESENTATIONS, AND SEMINARS

- “Autonomy On-Orbit and Beyond: Expanding Mission Capabilities in Space Robotics,” Department of Aerospace Engineering, University of Maryland College Park, College Park, MD, 2024.
- “Autonomy On-Orbit and Beyond: Expanding Mission Capabilities in Space Robotics,” Department of Astronautical Engineering, University of Southern California, Los Angeles, CA, 2024.
- “Autonomy On-Orbit and Beyond: Expanding Mission Capabilities in Space Robotics,” Department of Aeronautics and Astronautics, Massachusetts Institute of Technology, Cambridge, MA, 2024.
- “Autonomy On-Orbit and Beyond: Expanding Mission Capabilities in Space Robotics,” Department of Mechanical Engineering, University of Colorado Boulder, Boulder, CO, 2024.
- “Autonomy On-Orbit and Beyond: Expanding Mission Capabilities in Space Robotics,” Department of Aeronautics and Astronautics, Stanford University, Palo Alto, CA, 2024.
- “Autonomy On-Orbit and Beyond: Expanding Mission Capabilities in Space Robotics,” University of Washington, Seattle, WA, 2024.
- “Autonomy for Robotic Space Exploration: Roving through the Modern Autonomy Stack,” Morgan State University, Baltimore, MD, 2023.
- Multiple quarterly research presentations, *Astrobee Working Group*, NASA Ames, Moffet Field, CA, 2019 - 2021.
- Multiple research presentations, *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2021, 2022.
- “The Case for Parameter-Aware Control of Assistive Free-Flyers,” *AIAA SciTech GNC*, Nashville, TN (Virtual), 2021.
- Multiple research presentations, *IEEE Aerospace Conference*, Big Sky, MT, 2018 - 2020.
- Multiple presentations, *ROAM and ReSWARM ISS Investigation Kickoff*, CASIS/NASA, (Virtual), 2020.
- “Model Predictive Control and Integration with the Autonomy Stack of the Astrobee Free-Flyer,” *International Symposium on Artificial Intelligence, Robotics and Automation in Space (iSAIRAS)*, Pasadena, California (Virtual), 2020.
- “Kinodynamic-RRT for Robotic Free-Flyers: Generating Feasible Trajectories for On-orbit Mobile Manipulation,” *International Conference in Robotics and Automation (ICRA) Workshop: Toward Online Optimal Control of Dynamic Robots*, Montreal, Canada, 2019.
- Participant, *NASA in-Space Assembled Telescope (iSAT) Study Seminar*, NASA Langley, Hampton, VA, 2019.

FLIGHT PROJECTS

Cooperative Autonomous Distributed Robotic Explorers (CADRE) 2022 - Present

- Set of three fully autonomous lunar rovers running a modern robotics software stack, launching to the Moon.
 - Among CADRE’s “firsts” are: first fully autonomous planetary/lunar rover(s); first use of trajectory optimization on another celestial body; first multi-agent robotic planetary/lunar rovers.
- Responsible for developing, implementing, and testing motion planning, distributed leader election, and other algorithms; only member of both the autonomy and GNC subteams.

Astrobee 2020-2022

- Led MIT Space Systems Lab (SSL) transition from the SPHERES microgravity robotics platform to NASA’s Astrobee free-flyer aboard the International Space Station (ISS). Created science testing codebase, procedures, and operations for MIT’s first-ever on-orbit Astrobee test.

- Managed, coded, and flew multiple international flight collaborations between MIT, NASA, German Aerospace Center (DLR), University of Lisbon, Technical University of Munich (TUM), Royal Institute of Technology (KTH).

Robotic Operations for Autonomous Maneuvers (ROAM) 2021-2022

- Astrobee autonomous on-orbit microgravity rendezvous collaboration with DLR/TUM for on-orbit servicing and debris mitigation.
- Work resulted in two ISS test sessions and the [first known on-orbit rendezvous with an uncooperative, uncharacterized tumbling target](#).

Relative Satellite Swarming and Robotic Maneuvering (ReSWARM) 2020-2022

- Investigation into information-aware and robust motion planning and control under uncertainty techniques, allowing robots to learn about model unknowns and navigate with enhanced safety, in collaboration with KTH and University of Lisbon.
- Flew two ISS test sessions demonstrating the above algorithms for Astrobee cargo manipulation and on-orbit assembly.

SPHERES 2017-2019

- Reconfigurable multi-agent GNC and autonomy testbed aboard the ISS, developed by MIT SSL.
- Assisted in operations and code development for multiple SPHERES on-orbit investigations into real-time stereo-based factor graph pose estimation, including operation of the final SPHERES test session on Dec-31, 2019.

FUNDED AND IN-REVIEW PROPOSALS

- Co-I, “Autonomous Multi-Agent Robotics for Science-Gathering: Fostering Exploration Robotics Connections with WHOI,” *JPL Center for Academic Partnerships*, ~\$20k. Seed collaboration with WARP Lab, WHOI. (In review.)
- JPL PI, Task Manager, “SmallSat Steward: Autonomous Online Learning and Planning for Safe Inspection of Cislunar Stations,” *University Smallsat Technology Partnership*, NASA STMD, ~\$500k, 2023. Collaboration with Prof. Oliver Jia-Richards, University of Michigan.
- Co-I, “Learning-Based Ammortized Optimization for Accelerating Robot Motion Planning,” *JPL Data Science Working Group Award*, ~\$50k, 2023.
- Co-I “Accelerating Optimization-Based Motion Planners for Surface Rover Platforms,” *JPL HBCU/MSI Special Funding Call*, ~\$10k, 2023. Seed collaboration with Prof. Getachew Befekadu, Morgan State University.

CERTIFICATIONS AND SKILLS

Skills: Optimal control/trajectory optimization, motion planning, reinforcement learning, optimization, robotic software architecting, robotic hardware testing, team-oriented field testing (e.g., ISS operations), technical project management, hardware mechanical prototyping, dynamical systems simulation.

Coding Languages/Tools: C/C++, CMake, Python 2/3, Docker, ROS, F#, MATLAB, Java (novice), SolidWorks, cross-compilation toolchains, Unix systems programming, optimization and MPC frameworks (e.g., CasADi, acados, GTSAM, g2o, etc.).

Languages: English (native proficiency), Russian (working professional proficiency), Spanish (limited working proficiency).

Certifications: Private Pilot (ASEL), SDI Advanced Open Water Diver, Amateur Radio (General Class).

HONORS AND AWARDS

JPL Team Award: CADRE GNC Team (First Autonomous Drive)	2023
NASA Space Technology Research Fellowship	2017 – 2022
State Department Critical Language Scholarship (Russian); studied in Nizhny Novgorod, Russia .	2019
Columbia University Excellence in Engineering Design Award (1 st of 16 senior design teams)	2017
Columbia University <i>magna cum laude</i> , Tau Beta Pi, and Pi Tau Sigma	2017
Aviation Week/AIAA 20 Twenties Honoree	2017