Keidai Iiyama

CONTACT INFORMATION

Graduate Student (Master's Program)
Intelligent Space Systems Laboratory (ISSL)
Department of Aeronautics and Astronautics, The University of Tokyo
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EDUCATION

M.E. in Aeronautics and Astronautics   Mar, 2021 (expected)
The University of Tokyo, Japan
Department of Aeronautics and Astronautics, School of Engineering
Thesis (planned): Semi-Autonomous Orbit Determination and Time Synchronization for Lunar Navigation Satellite System

B.E. in Aeronautics and Astronautics   Mar, 2019
The University of Tokyo, Japan
Department of Aeronautics and Astronautics, School of Engineering
Thesis: Navigation Satellite Constellation and Monitoring Station Arrangement for Lunar Global Navigation Satellite System (LGNSS) (Advisor: Prof. Ryu Funase)

FELLOWSHIPS and AWARDS

- **Nakajima Foundation Study Abroad Fellowship**   Sep, 2021 - Sep, 2023
  - Two-year funding (tuition: 3million yen/year + stipend: 2.4 million yen/year) for Ph.D. study abroad. Maximum 5 years for the stipend.
  - Agency: Nakajima Foundation, Japan

- **Study Abroad Musha Shugyo Program Travel Award**   Jan, 2020 – Feb, 2020
  - Travel expense to research at Georgia Institute of Technology as a visiting researcher.
  - Agency: School of Engineering, The University of Tokyo, Japan

- **WINGS CFS Fellowship**   Sep, 2019 - Present
  - Two years of stipend funding for graduate study.
  - Agency: WINGS CFS, The University of Tokyo, Japan

- **32nd ISTS student paper competition finalist**   Jun, 2019
  - For the paper "Optimization of the Navigation satellite constellation and Lunar Monitoring Station for Lunar Global Navigation Satellite System"

- **ARLISS 2017 Overall Winner & Accuracy Award**   Sep, 2017
  - The overall winner of the international CanSat competition, ARLISS.

RESEARCH INTERESTS

- Autonomous spacecraft GNC and decision-making with reinforcement learning.
- Spacecraft swarm and distributed space systems.
- Navigation at the lunar surface and cis-lunar space.
- Spacecraft trajectory design and optimization.
- Small satellite system design.

RESEARCH EXPERIENCE

Intelligent Space Systems Laboratory, The University of Tokyo   Apr, 2018 - Present
- Role: Graduate Student
- Advisor: Prof. Ryu Funase & Prof. Shinichi Nakasuka
- Research Topic: Optimization of navigation satellite arrangement and staged development strategy of Lunar Navigation Satellite System (LNSS)
  - Implemented a user positioning simulator for LNSS. Conducted positioning performance analysis for several constellations and lunar monitoring station arrangement patterns.
  - Investigated using satellite-to-satellite tracking to improve the orbit determination accuracy.
  - Implemented a Multi-Objective Monte-Carlo Tree Search algorithm to obtain a staged development strategy that could flexibly adjust to uncertainties and changes in area of interest.
  - Related Publications: (C2) (C3)

Space Systems Optimization Group, Georgia Institute of Technology   Jan, 2020 – Feb, 2020
- Role: Visiting Researcher
- Advisor: Prof. Koki Ho
- Research Topic: Landing site selection and divert maneuver planning with deep reinforcement learning
  - Developed an autoencoder + deep reinforcement learning + feedback controller framework that autonomously selects safe landing target site and plans divert maneuver from Lidar DEM observations during powered descent to planetary bodies.
  - Related Publications: (C1) (C4)

ACADEMIC APPOINTMENTS

- **Assistant researcher at ISAS/JAXA**   Apr, 2019 - Present
  Worked on EQUULEUS project at JAXA Institute of Space and Astronautical Science (ISAS)

TEACHING EXPERIENCE

- **Graduate Teaching Assistant**   Sep, 2019 – Feb, 2020
  - To Associate Professor Ryu Funase in "Astrodynamics"
  - Created report assignments, MATLAB codes.
  - Topics: orbit transfers, perturbation, flybys, DVEGA

PROJECTS

EQUULEUS: Equilibrium Lunar-Earth point 6U Spacecraft   Oct, 2017 - Present
- EQUULEUS is a 6U cubesat lunar mission jointly proposed by JAXA and the University of Tokyo to NASA. It was selected as the secondary payload of the EM-1 Mission (First flight of the NASA's new rocket, SLS).
- Contribution:
  - Thermal analysis with MATLAB and Thermal Desktop.
  - Heater control and FDIR algorithm design.
  - Flight software development and implementation with C
  - Thermal dynamics and propulsion system simulator design and implementation with C++
  - Eclipse analysis and halo orbit escape maneuver analysis with MATLAB.
- Related Publications: (J1) (C5) (C6) (C7)

Working group at ISAS/JAXA   Aug, 2019 - Present
- Working group in ISAS (29 members) to propose a novel deep space exploration mission toward outer planets.
- Developed a software framework that constructs the multiple gravity-assist trajectory databases to the outer planets and effectively generates initial guess trajectories.
- Interacted with interdisciplinary researchers in ISAS, and coordinated the bus system to meet the requirements and constraints.

ARLISS (A Rocket Launch for International Student Satellites)   Apr, 2017 – Sep, 2017

- ARLISS is a cansat competition in Black Rock, Nevada. Cansats developed by the participants are launched by rockets, going up high to 4km. In the comeback competition, the participating teams integrate an autonomous system (including cases, parachutes, and rovers) to direct the CanSat to a designated location.
- Our team won the <u>overall winner</u> and <u>best accuracy award</u> (0 m), which is given to the team that successfully controlled the rover closest to the designated target.
- I contributed to the algorithm design and on-board software implementation for the flight sequence.

PUBLICATIONS and PRESENTATIONS

Publications are uploaded at https://kdricemt.github.io/publications/

Journal Publications

Co-Author

(J1) Funase, R., Ikari, S., Miyoshi, K., et al., (**as 20th author**) " Mission to Earth-Moon Lagrange Point by a 6U CubeSat: EQUULEUS", IEEE Aerospace & Electro. Systems Magazine, Vol.35, No.3, pp.30-44, 2020

Conference Proceedings (Selected)

First Author (All presented by Keidai Iiyama)

(C1) **Iiyama, K,** Tomita, K., Jagatia, B.A., Nakagawa, T., and Ho, K., "Deep Reinforcement Learning for Safe Landing Site Selection with Concurrent Consideration of Divert Maneuvers", 2020 AAS/AIAA Astrodynamics Specialist Conference, USA, August, 2020

(C2) **Iiyama, K.**, Ozaki, N., Kawabata, Y., Funase, R., and Nakasuka, S. "The Optimization of Staged Development of Lunar Navigation Satellite System", Space Sciences and Technology Conference, Tokushima, Japan, November, 2019 (Written in Japanese).

(C3) **Iiyama, K**., "Optimization of the Navigation satellite constellation and Lunar Monitoring Station for Lunar Global Navigation Satellite System", 32nd International Symposium on Space Technology and Science, Japan, j-20s, June, 2019, **Student session finalist**

Co-Author (All presented by the first author)

(C4) Tomita, K., Skinner, K., **Iiyama, K.**, Jagatia, B.A., Nakagawa, T., and Ho, K., "Real-Time Terrain Mapping and Processing for Safe Landing via Deep Neural Networks", ASCEND, Las Vegas, Nevada, The United States, November, 2020

(C5) Dei Tos, D.A., Baresi, N., Chikazawa, T., Campagnola, S., Kawabata, Y., **Iiyama, K.**, Kakihara, K., Ozaki, N., Funase, R., and Kawakatsu. Y., "Challenges and Solutions for the Trajectory Design of EQUULEUS", 29th Workshop on Astrodynamics and Flight Mechanics, Kanagawa, Japan, July, 2019

(C6) Matsushita, S., Shibukawa, T., **Iiyama, K.**, and Funase, R. "Thermal Design and Validation for a 6U Cubesat EQUULEUS under Constraints Tightly Coupled with Orbital Design and Water Propulsion System", 49th International Conference on Environmental Systems, USA, July, 2019.

(C7) Shibukawa, T., Matsushita, S., **Iiyama, K.**, and Funase, R., "Reflection and Verification of Thermal Design under Tightly-Coupled Constraints to the 6U Deep Space CubeSat EQUULEUS", 32nd International Symposium on Space Technology and Science, Fukui, Japan, June, 2019.

MISCELLANEOUS

- **Language:** English (Professional proficiency), Japanese (Native)
- **Test Scores:**
  - GRE V: 155/170 (67%), Q: 169/170 (94%), A/W: 4.0 (55%)
  - TOFEL iBT 105/120
- **Programming Language:** Python, C, C++, MATLAB, Javascript
- **Software, Frameworks, Tools:**
  - Trajectory Design: SPICE Toolbox (celestial body ephemeris), jTOP (spacecraft trajectory design software)
  - Engineering: Thermal Desktop, CAD (Autodesk Inventor)

- Reinforcement learning: Pytorch, OpenAI Gym
- Web: React
- Others: Subversion, Git, Raspberry Pi

Last Updated: November 30, 2020