

Daigo Kobayashi

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Summary

Ph.D. candidate with strong skills in image processing, machine learning, and orbit mechanics for the application in space domain awareness. Currently focusing on the application of computer vision for autonomous pose and shape estimation of spacecraft. Expected to graduate in 2025 Summer.

Education

Purdue University, Ph.D. in Aeronautical and Astronautical Engineering May 2020 – May 2025

- GPA: 4.00/4.00
- **Advisor:** Prof. Carolin Frueh
- **Thesis title:** Computer Vision for Space Domain Awareness: Exhaustive Research in LEO and Higher Orbits

Purdue University, M.S. in Aeronautical and Astronautical Engineering August 2018 – May 2020

- GPA: 3.71/4.00
- **Advisor:** Prof. Carolin Frueh
- **Thesis title:** Exploration of Compressed Sensing for Satellite Characterization

Waseda University, Tokyo, Japan, B.S. in Mechanical Engineering April 2014 – March 2018

- GPA: 3.60/4.00
- **Advisor:** Prof. Tomoyuki Miyashita
- **Thesis title:** Hierarchical Optimization of Truss Support Structure for Space Solar Power System

Journal Articles

- **Daigo Kobayashi** and Carolin Frueh. "Image Recovery of LEO Objects by Leveraging Optical Turbulence and Light Curves." In: **Journal of Guidance, Control, and Dynamics** (2024), DOI: 10.2514/1.G007634
- Daniel Galea, Hsi-Yen Ma, Wen-Ying Wu, and **Daigo Kobayashi**. "Deep Learning Image Segmentation for Atmospheric Rivers." In: **Artificial Intelligence for the Earth Systems** (2024), DOI: 10.1175/AIES-D-23-0048.1

Conference Proceedings

- **Daigo Kobayashi**, Alexander Burton, and Carolin Frueh. "AI-Assisted Near-Field Monocular Monostatic Pose Estimation of Spacecraft". In: Proceedings of the Advanced Maui Optical and Space Surveillance Technologies Conference. September 2023.
- **Daigo Kobayashi** and Carolin Frueh. "Compressed Sensing for Enhanced Space Security: Resolving Details of Space Objects". In: CERIAS 24th Security Symposium. March 2023.
- **Daigo Kobayashi** and Carolin Frueh. "Image-based Satellite Characterization for Low Earth Orbit". In: 33rd AAS/AIAA Space Flight Mechanics Conference. January 2023
- **Daigo Kobayashi** and Carolin Frueh. "Reformulating Compressed Sensing to be used with SemiResolved Point Spread Function and Light Curves for Space Object Imaging: LEO". In: Proceedings of the Advanced Maui Optical and Space Surveillance Technologies Conference. September 2022.
- **Daigo Kobayashi** and Carolin Frueh. "Compressed Sensing for Satellite Characterization: Shadowing as a Sensing Matrix". In: 8th European Conference on Space Debris. April 2021.
- **Daigo Kobayashi** and Carolin Frueh. "Compressed Sensing for Satellite Characterization: A First Step Using Simulations". In: 43rd COSPAR Scientific Assembly. February 2021.
- **Daigo Kobayashi** and Carolin Frueh. "Compressed Sensing for Satellite Characterization". In: AIAA/AAS Astrodynamics Specialist Conference. August 2020.

Honors

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| Bilsland Dissertation Fellowship , Purdue University – \$72,000 | May 2024 - May 2025 |
| ITO International Fellowship , ITO Foundation, Japan – \$75,000 | August 2018 - July 2020 |
| Tosoh Corporation Scholarship , Tosoh Corporation, Japan – \$5,000 | April 2016 - March 2018 |
| Valedictorian , Waseda University, Japan | March 2018 |

Academic Service

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| Teaching assistant in AAE 59000: Space Traffic Management | August - December 2023 |
| Mentor in Undergraduate Research Program at Purdue University | January 2020 - March 2021 |
| Reviewed a journal manuscript for <i>Journal of Spacecraft and Rockets</i> | March 2021 |
| Reviewed a journal manuscript for <i>The Astrodynamics</i> | January 2020 |

Work Experience

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| Intern , Lawrence Livermore National Laboratory – Livermore, CA | June – August 2023 |
| <ul style="list-style-type: none">• Validate LLNL-developed image simulator by matching real data to simulation output.• Develop a digital twin of a large telescope to characterize the systematic distortion in astronomical images. | |
| Intern , Lawrence Livermore National Laboratory – Livermore, CA | May – August 2022 |
| <ul style="list-style-type: none">• Discover bugs in an in-house deep learning software, the Regularized Adversarial Domain Adaptation (RADA), and produced a user manual to facilitate the use of the software.• Predict extreme weather events accurately from geospatial data by developing a deep learning algorithm. | |
| Technical Trainee , Japan Aerospace Exploration Agency (JAXA) – Japan | April 2017 – March 2018 |
| <ul style="list-style-type: none">• Achieved 90% reduction of the mass of a km-size support truss structure for Space Solar Power System (SSPS) by structural optimization based on response surface method. | |

Projects

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| Characterization of Resident Space Objects based on Light Curve | January 2020 - Present |
| <ul style="list-style-type: none">• The first example of applying an image compression algorithm, i.e., compressed sensing, to recover an image of unknown space object based on ground-based data.• Develop a digital twin of atmosphere-induced optical turbulence based on the split-step propagation through phase screens to model the ground-based observation of objects in low Earth orbit. | |
| Multi-Vehicle Navigation Project with Boeing | January 2023 - Present |
| <ul style="list-style-type: none">• Develop a hardware-in-the-loop pipeline to estimate the 6 DoF pose of a space object using machine learning algorithm both on synthetic and real dataset with severe illumination conditions.• Develop an algorithm to estimate both shape and pose of an unknown space object based on a observation sequence using a monocular optical camera. | |
| RAVE Project with the Sandia National Laboratories | January 2020 - January 2021 |
| <ul style="list-style-type: none">• Develop a machine learning algorithm to detect and classify airplanes in aerial photographs even with partial occlusion, low contrast, and other measurement noise. | |

Technologies

Languages: Python, PyTorch, MATLAB, SolidWorks, Blender, Julia, General Mission Analysis Tool (GMAT)

Technologies: Machine Learning, Image Processing, Fourier Optics, Optical Imaging System Design (e.g., Zemax OpticStudio), Orbit Mechanics, 3D Printing, Embedded Systems Development (e.g., Raspberry Pi)