PABLO MACHUCA

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Visiting Assistant Professor at San Diego State University, California, USA (August 2023–Present)
Last updated: August 2023

EDUCATION

Cranfield University, Cranfield, Bedfordshire, UK **September 2017–April 2021**
Ph.D. in Aerospace Engineering – Trajectory Design and Autonomous Navigation and Guidance for Interplanetary CubeSats

Purdue University, West Lafayette, Indiana, USA **August 2015–May 2017**
Master of Science in Aeronautics and Astronautics – Astrodynamics and Space Applications **GPA: 3.93/4.00**
Minor in Dynamics and Control

Universidad Carlos III de Madrid, Leganés, Madrid, Spain **September 2011–July 2015**
Bachelor's Degree in Aerospace Engineering **Grade: 8.3/10.0**
Graduated third in a class of 60 students, 4-year program taught fully in English

Research Interests: Deep-space Exploration, Mission Analysis, Astrodynamics, Trajectory Design, Autonomous Guidance, Navigation and Control, Uncertainty Quantification, Spacecraft Attitude Dynamics, Systems Design

TEACHING AND PROFESSIONAL EXPERIENCE

Massachusetts Institute of Technology, USA **September 2022–August 2023**
Postdoctoral Associate on 'Evolutionary Space Debris Model through Monte Carlo Simulations'
Advisor: Prof. Richard Linares – Department of Aeronautics and Astronautics
– Implementation and validation of Monte-Carlo simulation framework for propagation of LEO to GEO space debris population (e.g., analytical and semi-analytical propagators, break-up models, comparison with source-sink model, etc.)
– Development of a calibrated source-sink evolutionary model to efficiently and more accurately reproduce dynamics observed in Monte Carlo simulations for the propagation of space debris populations

University of California San Diego, USA **September 2021–September 2022**
Postdoctoral Researcher on 'Space Situational Awareness for Cislunar Space'
Advisor: Prof. Aaron J. Rosengren – Department of Mechanical and Aerospace Engineering
– Provided catalog of cislunar trajectories of interest (periodic orbits and transfers) in the three-body and ephemeris models
– Characterized and propagated orbit determination uncertainties to assess their effect on cislunar catalog maintenance

Universitat Politècnica de Catalunya/Universitat de Barcelona, Spain **April 2018–December 2018**
Visiting Researcher on 'High-fidelity Trajectory Design to Fly-by Near-Earth Asteroids Using CubeSats'
Advisors: Prof. Josep J. Masdemont – Department of Mathematics/Prof. Gerard Gómez – Department of Mathematics and Computer Science
– Designed high-impulse and low-thrust asteroid fly-by trajectories for CubeSats in the three-body and ephemeris models

Purdue University, USA **August 2015–May 2017**
Graduate Teaching Assistant in First-year Engineering Program – School of Engineering Education
Advisor: Prof. Michele L. Strutz – School of Engineering Education
– Developed instructional material, introduced freshmen students to engineering thinking and modeling, taught students Excel and MATLAB, and occasionally lectured a class of 120 freshmen engineering students
– Mentored ten undergraduate teaching assistants each semester to manage flipped classroom environment and grading tasks

NASA Goddard Space Flight Center, USA **June 2016–August 2016**
Student Research Assistant on 'CANYVAL-X CubeSat Mission'
Advisor: Mr. Philip C. Calhoun – Attitude Control and Systems Engineering Branch
– Implemented realistic environmental models (e.g., geomagnetic field, Earth's albedo), and small-spacecraft sensors and actuators (e.g., magnetometer, sun sensor, ion thrusters) for CubeSat control simulation tool in Simulink

RESEARCH PROJECTS (SELECTED)

Cranfield University, United Kingdom/JAXA's ISAS Research Center, Japan **July 2020–September 2021**
Postdoctoral Researcher on 'Guidance, Navigation and Control for JAXA's Probe on the 2028 Comet-I Mission'
Advisors: Prof. Joan Pau Sánchez – School of Aerospace, Transport and Manufacturing/Prof. Naoya Ozaki – JAXA Institute of Space and Astronautical Science
– Implemented stochastic model of dust environment for the hyperbolic fly-by of an *a priori* unknown long-period comet
– Analyzed effect of hypervelocity impacts of dust particles on the attitude control and stability of JAXA's 24U probe
– Derived system requirements for attitude control and explored strategies for autonomous GNC during hyperbolic fly-by

Cranfield University, United Kingdom **September 2017–December 2020**
Ph.D. Candidate on 'Trajectory Design and Autonomous Navigation and Guidance for Interplanetary CubeSats'
Advisor: Prof. Joan Pau Sánchez – School of Aerospace, Transport and Manufacturing
– Proposed strategies for deep-space autonomous navigation and guidance to fly-by near-Earth asteroids using CubeSats
– Designed high-impulse and low-thrust trajectories, derived system requirements, and proposed a CubeSat systems design

Universidad Carlos III de Madrid, Spain/Purdue University, USA **January 2017–August 2017**
Graduate Researcher on 'Robust Optimization of Descent Trajectories on Asteroids'
Advisor: Prof. Manuel Sanjurjo Rivo – Department of Bioengineering and Aerospace Engineering
– Implemented polyhedron and mascons gravitational models, and leveraged stochastic optimization techniques for design of asteroid descent trajectories in the presence of uncertainty

JOURNAL PUBLICATIONS

- **Machuca, P.**, Ozaki, N., Sánchez, J.P., Felicetti, L., "Dust Impact and Attitude Analysis for JAXA's Probe on the Comet Interceptor Mission" (**May 2022**) ■ Journal article in Advances in Space Research https://doi.org/10.1016/j.asr.2022.05.070
- **Machuca, P.**, Sánchez, J.P., "CubeSat Autonomous Navigation and Guidance for Low-cost Asteroid Fly-by Missions" (**November 2021**) ■ Journal article in Journal of Spacecraft and Rockets https://doi.org/10.2514/1.A34986
- **Machuca, P.**, Sánchez, J.P., Masdemont, J.J., Gómez, G., "High-fidelity Trajectory Design to Fly-by Near-Earth Asteroids Using CubeSats" (**February 2020**) ■ Journal article in Acta Astronautica https://doi.org/10.1016/j.actaastro.2019.09.041
- **Machuca, P.**, Sánchez, J.P., Greenland, S., "Asteroid Fly-by Opportunities Using Semi-autonomous CubeSats: Mission Design and Science Opportunities" (**January 2019**) ■ Journal article in Planetary and Space Science https://doi.org/10.1016/j.pss.2018.11.002

CONFERENCE PRESENTATIONS AND PAPERS (SELECTED)

- Jang, D., Siew, P.M., **Machuca, P.**, Linares, R., "Monte Carlo Methods for All-vs-all Future LEO Population Evolution Modeling" (**September 2023**) ■ Poster and conference paper at 2023 Advanced Maui Optical and Space Surveillance Technologies Conference (AMOS)
- Kilduff, T., **Machuca, P.**, Rosengren, A.J., Linares, R., "Crater Detection for Cislunar Autonomous Navigation through Convolutional Neural Networks" (**August 2023**) ■ Oral presentation and conference paper at 2023 AAS/AIAA Astrodynamics Specialist Conference
- Wu, C.X., **Machuca, P.**, Felicetti, L., "Autonomous Optical Navigation for Small Spacecraft in Cislunar Space" (**September 2022**) ■ Oral presentation at 2022 International Astronautical Congress (IAC)
- **Machuca, P.**, Rosengren, A.J., Ross, S.D., "xGEO Space Domain Awareness: Parametrization and Characterization of Cislunar Space" (**September 2022**) ■ Poster and conference paper at 2022 Advanced Maui Optical and Space Surveillance Technologies Conference (AMOS)
- **Machuca, P.**, Ozaki, N., Sánchez, J.P., Felicetti, L., Funase, R., "System Requirements Analysis for JAXA's Contribution to Comet Interceptor Mission: Attitude Control for a Hyperbolic Comet Fly-by" (**October 2020**) ■ Oral presentation and conference paper at 2020 International Astronautical Congress (IAC)
- **Machuca, P.**, Sánchez, J.P., "Autonomous Navigation and Guidance for CubeSats to Fly-by Near-Earth Asteroids" (**October 2019**) ■ Oral presentation and conference paper at 2019 International Astronautical Congress (IAC)
- **Machuca, P.**, Sánchez, J.P., Masdemont, J.J., Gómez, G., "Low-energy Trajectory Design and Autonomous Navigation to Fly-by Near-Earth Asteroids Using CubeSats" (**October 2018**) ■ Oral presentation and conference paper at 2018 International Astronautical Congress (IAC)
- **Machuca, P.**, Sánchez, J.P., "NEARCube: Using Autonomous 3U CubeSats to Fly-by Near-Earth Asteroids" (**July 2018**) ■ Oral presentation at 2018 COSPAR Scientific Assembly
- **Machuca, P.**, González-Arribas, D., Morante-González, D., Sanjurjo-Rivo, M., Soler, M., "Robust Optimization of Descent Trajectories on Irregular-shaped Bodies in the Presence of Uncertainty" (**August 2017**) ■ Oral presentation and conference paper at 2017 AAS/AIAA Astrodynamics Specialist Conference

RELATED ACTIVITIES AND AWARDS (SELECTED)

Margarita Salas Postdoctoral Fellowship – Universidad Carlos III de Madrid, Spain **October 2022**
– Successful 24-month project proposal for research at JAXA's ISAS research center and Universidad Carlos III de Madrid (turned down because of MIT offer)

JSPS Postdoctoral Fellowship for Research in Japan (Short-term) **September 2020**
– Successful 12-month project proposal for research at JAXA's ISAS research center (turned down because of pandemic)

ESA Sponsorship for 2018 IAC, ISEB Student Participation Program, and Space Generation Congress **May 2018**
– Awarded sponsorship to attend IAC conference and associated events as an ESA student representative

Magoon Award for Excellence in Teaching – College of Engineering at Purdue University, USA **March 2017**
– Recognized as an outstanding Graduate Teaching Assistant based on student evaluations and faculty recommendation

Universidad Carlos III de Madrid Excellence Award – Sponsored by Airbus Group **April 2015**
– Became one of the two awardees in the Department of Aerospace Engineering for undergraduate academic excellence