Mattia **Pugliatti**

PH.D. STUDENT · GNC & MISSION DESIGN

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"You never fail until you stop trying"

Research interests

I am a curious, ambitious and creative researcher. My areas of interest are autonomous optical navigation, artificial intelligence, GNC, and small-bodies exploration. My career goal is to become a specialist in interplanetary missions and autonomous GNC design.

Experience

Ph.D. Student & Early Stage Researcher

Milan, Italy

POLITECNICO DI MILANO, *DART laboratory* — *Nov. 2019 - Present*

- Artificial intelligence for enhanced optical navigation techniques around small-bodies. Design and validation of autonomous GNC systems for interplanetary CubeSats.
- Mission analysis, image processing, and GNC design of the Milani mission. Team leader of the GNC group for the Milani mission.
- Marie Skłodowska Curie ESR13 of Stardust-R, the European Training Network on asteroids and space debris.

Visiting researcher

Bremen, Germany

DEUTSCHES FORSCHUNGSZENTRUM FÜR KÜNSTLICHE INTELLIGENZ, *DFKI* — *Feb. 2023 - May. 2023*

- Visiting researcher at the German center for artificial intelligence under the supervision of Dr. Marko Jankovic and Prof. Frank Kirchner.
- Visual digital twin of an analog crater facility for data-driven applications.
- Dataset generation with a Vicon-drone camera setup. Pose and visual labeling of the images with a digital twin.

Visiting researcher

Tucson, Arizona, USA

UNIVERSITY OF ARIZONA, *SSEL* — *Sept. 2021 - Jan. 2022*

- Visiting researcher at the Space System Engineering Laboratory under the supervision of professor Roberto Furfaro.
- Deep-learning and convolutional extreme learning machine methods for precise optical navigation in the proximity of a small-body.
- Recurrent neural networks and reinforcement learning for autonomous close-proximity operations.

GNC project engineer

Madrid, Spain

GMV, *SPS/GNC division - Interplanetary section* — *Sept. 2018 - Sept. 2019*

- GNC project engineer of the HERA mission, a technology demonstration mission to visit the Didymos binary system.
- Design and testing of the visual based navigation strategy for the proximity operation phases of the Hera mission for phases A and B1.
- Incremental testing and validation campaign using higher fidelity models: model-in-the-loop (with PANGU), software-in-the-loop and hardware-in-the-loop (responsible for the optical facility testbench and robotic facility simulations).

Visiting researcher

Sagamihara, Japan

JAXA, *Institute of Space and Astronautical Science* — *March. 2017 - Nov. 2017*

- Visiting researcher under the supervision of professor Yasuhiro Kawakatsu.
- Member of the trajectory design teams of EQUULEUS CubeSat and DESTINY smallsat missions.
- EQUULEUS: 6U CubeSat to be deployed during the maiden flight of the SLS to reach a NRHO about the L2 point of the Earth–Moon system. Team leader of the first-guess trajectory design group. Maintenance and implementation of a toolbox for the generation of large set of first-guess transfer trajectories in full-ephemeris model of the Sun–Earth–Moon system using SPICE and jPRO.
- DESTINY: Technology demonstration mission to investigate Phaethon asteroid. Trajectory design of the multiple lunar flyby phase with the application of a Moon-to-Moon database in the Earth–Moon CR3BP.

Internship

Friedrichshafen, Germany

AIRBUS DEFENCE AND SPACE, *Future programmes department* — *Jul. 2016 - Dec. 2016*

- Mission and spacecraft design of $NEOT\omega IST$, a low-cost impactor demonstration and characterization mission on Itokawa. Part of the NEOShield-2 project, supported by the European programme H2020.
- Focus on the flyby trajectory and formation flight design, high level assessment of a tracking strategy, and system engineering design of the flyby module.

Education

Delft University of Technology *Delft, The Netherlands*

M.Sc. in Spaceflight *Sep. 2015 - Mar. 2018*

- Specialization in space exploration, transfer orbit profile.
- Key courses: Mission Geometry and Orbit design, Planetary sciences, Astrodynamics I & II, Space Project, Microsatellite engineering.
- Thesis on the Extended Tisserand–Poincaré graph for multi-body trajectory design in the patched CR3BP model: Extension of the current theoretical framework in the CR3BP of the Tisserand parameter about the primary to a modified Tisserand parameter about the secondary, existing on a specific family of Poincaré sections.
- Generic formulation valid for any patched CR3BP model sharing the same body as primary and secondary, with applicability for EQUULEUS and DESTINY in the Sun–Earth–Moon system, and for capture trajectories in the Sun–Jupiter–Europa system.
- Final grade: 9.5/10 Cum Laude. Manuscript available at TU Delft repository.

Politecnico di Milano *Milan, Italy*

B.Sc. in Aerospace Engineering *Sep. 2012 - Sep. 2015*

- Key courses: Fundamental of Space Missions, Applied Numerical Analysis, Theoretical Mechanics, Automatic Control.
- Final grade: 106/110.

Publications (selected)

- **J1**: *Data-Driven Image Processing for Onboard Optical Navigation Around a Binary Asteroid*, **M. Pugliatti**, V. Franzese, F. Topputo. Journal of Spacecraft and Rockets, 2022. doi: 10.2514/1.A35213
- **J2**: *Small-Body Segmentation Based on Morphological Features with a U-Shaped Network Architecture*, **M. Pugliatti**, M. Maestrini. Journal of Spacecraft and Rockets, 2022, Volume 59, Issue 6, doi: 10.2514/1.A35447
- **J3**: *Trajectory Options for Hera's Milani CubeSat Around (65803) Didymos*, F. Ferrari, V. Franzese, **M. Pugliatti**, C. Giordano, F. Topputo. Journal of the Astronautical Sciences, 2021. doi: 10.1007/s40295-021-00282-z
- **C1**: *Navigation about irregular bodies through segmentation maps*, **M. Pugliatti**, F. Topputo, 31st Space Flight Mechanics Meeting, Charlotte, NC, 1-3 Feb 2021.
- **C2**: *Onboard small-body semantic segmentation based on morphological features with U-Net*, **M. Pugliatti**, M. Maestrini, P. Di Lizia, F. Topputo, 31st Space Flight Mechanics Meeting, Charlotte, NC, 1-3 Feb 2021.
- **C3**: *Small-Body shape recognition with Convolutional Neural Network and comparison with explicit features based methods*, **M. Pugliatti**, F. Topputo, Astrodynamic Specialist Conference, Lake Tahoe, CA, 9-12 Aug 2020.

Space missions contributions

- **MILANI**: Mission analysis and GNC design and analysis, with a particular focus on autonomous OpNav techniques. Team leader of the GNC group. Designer of the image processing software. (2+ years of experience, from proposal to phase C)
- **HERA**: Testing of the visual-based navigation strategy. Model-in-the-loop, software-in-the-loop, hardware-in-the-loop with engineering camera model, optical laboratory and robotic facility. (1 year of experience, phases A and B1)
- **EQUULEUS**: Mission analysis and trajectory design in a high-fidelity multi-body system. (9 months of experience, phase A)
- **DESTINY+**: Mission analysis and trajectory design in a patched conics dynamic. (9 months of experience, phase A)
- **NEOTωIST**: Mission and spacecraft design, flyby trajectory and formation flight design, high level assessment of a tracking strategy and system engineering of the flyby module. (5 months of experience, phase 0)

Honors & Awards

Rocca fellowship *Boston-Milan*

MIT-Politecnico di Milano *May 2022*

- Scholarship provided to fund 6-12 months of research stays at MIT for 5-6 Politecnico di Milano Ph.D. students every year. Progetto Roberto Rocca.
- A grant provided with the aim to increase the exchange of ideas between Massachusetts Institute of Technology and Politecnico di Milano.

Technical skills

- Programming languages and software: Python, Matlab, Simulink, STK, jPRO, C++, LaTeX.
- Operative systems: Linux, Microsoft, MacOS.
- Others: Blender, PANGU, Git, SPENVIS, Excel, Word, Power point.
- Teamwork: Problem solving, extensive experience in international teams (7+ years), fit for leadership positions, at ease with pressure.
- Supervision: Co-supervisor of the M.Sc. thesis work of 8 students.

Languages and personal interests

- Italian (Mother tongue), English (Advanced, TOEFL: 114/120 Nov 2017), Spanish & German (basic).
- I love backpacking, travelling around the world, exploring disparate cultures and tasting the most extravagant foods.