Maxime Robic

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EDUCATION

- **Ph.D, Robotics, Automation, Production Engineering,** University of Rennes
  - Advisors: DR François Chaumette and Pr. Eric Marchand
  - Viva: 12/12/2023
  - Thesis title: "*Visual Servoing of the Orientation of an Earth Observation Satellite*"
  - Link: https://theses.hal.science/tel-04435105/document
  - Fellowship: BPI LiCHiE, National project led by Airbus Defence & Space with the collaboration of Inria, University of Rennes, France.

- **Master, Embedded Computer Sciences,** University of Poitiers, ISAE-ENSMA
  - Degree awarded: 01/10/2020

- **Engineering Diploma, Aeronautics,** ISAE-ENSMA
  - Degree awarded: 01/10/2020

PROFESSIONAL EXPERIENCE

Department of Aerospace Science and Technology, Politecnico di Milano, Italy　　　　　**From 01/12/2025**

DART Team　　　　　　　　　　　　　　　　　　　　　　　　　　　　　MSCA fellow researcher

- Researcher in the DART team (web https://dart.polimi.it/team/)
- RGB-Event based GNC for servicing satellites.
- Main collaborator of the MSCA project TANGO, led by Polimi.

MIS Laboratory, University of Picardy Jules Verne, Amiens, France　　　　　**13/05/2024 – 13/11/2025**

Robotic Perception Team　　　　　　　　　　　　　　　　　　　　　　　Postdoctoral researcher

- Researcher in the Robotic Perception team (web: https://www.mis.u-picardie.fr/perception-robotique)
- Event-based omnidirectional vision for UAVs tracking, navigation, and communication.
- Collaborator of the ANR project DEVIN, led by University of Côte d'Azur.
- Collaborator of the ANR project EVELOC, led by University of Picardy Jules Verne.

Inria, University of Rennes, Rennes, France　　　　　　　　　　**01/11/2020 – 31/12/2023**

Rainbow Team　　　　　　　　　　　　　　　　　　　　　　　　　　　Ph.D. candidate

- Researcher in the Rainbow Team (web: https://team.inria.fr/rainbow/fr/).
- Visual servoing guidance for a novel optical satellite.
- Tracking algorithm for high-speed targets under mechanical and acquisition constraints.
- Collaborator of the national project BPI LiCHiE, led by Airbus Defence & Space.

ONERA, Toulouse, France   14/04/2020 – 03/10/2020

DTIS department   Research intern

- Literature review on semantic SLAM.
- Camera/Lidar data fusion for the texturization node of a SLAM.

Auckland University of Technology, Auckland, New Zealand   01/06/2019 – 01/10/2019

Department of Computer Sciences   Visiting student

- Design of a soft robotic gripper for fruit manipulation.

SAFRAN AEROSPACE, Châteaudun, France   01/07/2018 – 01/08/2018

Repairing Station   Intern

- Servovalve repair for helicopters.

EARLY ACHIEVEMENT TRACK RECORD

My PhD research work has innovatively contributed to both fields of robotic vision and Earth observation satellites. I exploited a new vision technology conceived by Airbus Defence & Space to manage the pre-study of the Guidance&Control (G&C) block of their next LION satellite constellation, aiming to operate high-precision target observation. My research work has led to the considering of the satellite guidance as a visual servoing task, and to designing adequate models so that orbital motions induced by satellite physics are directly embedded in the guidance law. I demonstrated successful tracking of any terrestrial objects moving or not, an important contribution to the field, and validated these results with real-world robotics experimentation, on a robotic manipulator and on a drone. I also solved historical problems of satellite observation, such as motion blur generation during the acquisition, proposing a vision-based barrier function in an optimal guidance approach. My PhD work led me to publish 1 journal article and 2 conference papers, but also to contribute significantly to an industrial project. These new satellites are expected to be launched in 2025, where an in-orbit demonstration is planned for research purposes.

During my postdoctoral position within the MIS laboratory from May 2024 to November 2025, my research has focused on the design of a novel omnidirectional event camera, and on the development of event-based algorithm to operate fast tracking of uncooperative UAV, but also for the navigation and communication of a drone in a fleet. Although this project was noticeably different from my PhD studies, I initially focused on the modeling and design of the novel SFERA omnidirectional event camera**.** This work has led to a publication that was recognized as a **Best Paper Award Finalist** at one of the most prestigious international robotics conferences. Subsequently, I concentrated on the development of a Bayesian omnidirectional tracker, based on an adaptation of the Kalman filter to non-Euclidean manifolds. This work is currently under review in a leading robotics journal. More recently, I have been investigating event-based communication strategies, resulting in both a survey paper and a conference submission, which are currently under review.

Finally, my TANGO project has been selected for funding under the **Marie Skłodowska-Curie Actions (MSCA)** program, supporting a two-year postdoctoral position within the DART (Deep-space Astrodynamics Research and Technology) team at Politecnico di Milano, from December 1st. This prestigious and highly competitive fellowship will enable me to pursue research that combines event-based and RGB camera technologies for Guidance, Navigation, and Control (GNC) of servicing satellites, within a world-class research group in astronautics.

Throughout my career, I developed a major interest for scientific communication, which has diversified my activities and led me to being involved in multiple talks on TV, Radio, industrial journeys or outreach events. As a scientific communicator, my biggest achievement was my 3rd place over 650 participants at 3-Minutes Thesis (Ma thèse en 180 seconds), a famous French communication competition where I demonstrated exceptional ease onstage.

RESEARCH EXPEDITIONS

(This Section refers to publications listed in the next Section)

1. **Visual servoing for the guidance of an Earth optical satellite**
   - Investigating closed-loop vision-based control approach to design the guidance block of an Earth observation satellite aiming to focus on a specific area of interest on the Earth.
   - Taking advantage of orbital mechanics to compensate for orbital motions of the satellite directly in the control law, and filtering techniques to regulate the unknown motion of a terrestrial high-speed target.
   - Publications: **C1, C2.**
   - Collaborators: DR François Chaumette, Pr. Eric Marchand, Renaud Fraisse.

2. **Mitigating motion blur during visual servo tasks through optimal visual servoing**
   - Design of a motion-blur free constraint derived from a sharpness metric and embedded in a visual servoing scheme thanks to an optimization box.
   - Application to the reduction of angular motions of an Earth observation satellite to acquire sharp images during the guidance.
   - Publications: **J1**.
   - Collaborators: DR François Chaumette, Pr. Eric Marchand, Renaud Fraisse.

3. **Design, model and evaluation of a stereo fisheye event camera**
   - Modeling of a novel event-based omnidirectional sensor composed of two fisheye cameras mounted in a back-to-back configuration.
   - Calibration and development of an event-based tracker on the panoramic view.
   - Publications: 1 conference paper **C3** focused on the design & modeling of the event sensor, 1 journal in submission **S1** focused on the omnidirectional event-based tracking algorithm.
   - Collaborators: Pr. Pascal Vasseur, Dr. Fabio Morbidi, Dr. Daniel Rodrigues Da Costa.

4. **Event-based communication**
   - State-of-the-art and review of communication algorithms using event-based camera.
   - Development of event-based communication algorithms leveraging event camera's high frequency acquisition.
   - Publications: 1 journal paper in submission **S2** proposing a survey on event-based optical marker systems, 1 conference paper in submission **S3** on event-based communication algorithms for flying drone.
   - Collaborators: Pr. Pascal Vasseur, Dr. Fabio Morbidi, Nafiseh Jabbari Tofighi.

PUBLICATION LIST

(* accounts for same contributions & randomized order)

Journal paper

(J1) **M. Robic**, R. Fraisse, E. Marchand and F. Chaumette. "QP-based Visual Servoing Under Motion Blur-Free Constraint", *IEEE Robotics and Automation Letter*. Submitted in September 2023. Accepted in August 2024.

- <u>Abstract:</u> This paper handles the reduction of motion blur through the achievement of a visual task. The technique proposed relies on the measurement of blur influence thanks to a sharpness metric, and its mapping into a control barrier function, encompassed in an optimization box. Several use cases have been proposed, including an Earth observation satellite, mimicked by a manipulator arm.
- <u>Link:</u> https://ieeexplore.ieee.org/document/10659115

Conference papers

(C1) **M. Robic**, R. Fraisse, E. Marchand and F. Chaumette. "Vision-based rotational control of an agile observation satellite", *IEEE/RSJ International Conference on Intelligent Robots and Systems, IROS'22.* Submitted in March 2022. Published in October 2022.

- <u>Abstract:</u> This paper investigates the design of a vision-based guidance scheme to control the orientation of an agile observation satellite. The focus is put on establishing the dynamic model linking the visual features to the satellite velocity.
- Link: https://ieeexplore.ieee.org/document/9981398

(C2) **M. Robic**, R. Fraisse, K. Lagadec, E. Marchand and F. Chaumette. "Visual servoing of an Earth observation satellite of the LION constellation", *73rd International Astronautical Congress, IAC'22.* Submitted in August 2022. Published in September 2022.

- <u>Abstract:</u> This paper acknowledges the visual model obtained in previous work, and pushes its integration into a real system. The focus is given on a predictive saturation algorithm that considers the dynamic response of the satellite. Several experiments are provided, including the tracking of moving targets with different unknown motion.
- Link: https://inria.hal.science/hal-03768194/

(C3) D.R. Da Costa*, **M. Robic***, P. Vasseur, F. Morbidi. "A New Stereo Fisheye Event Camera for Fast Drone Detection and Tracking", *IEEE International Conference on Robotics and Automation, ICRA'25.* Submitted in September 2024. Published in May 2025.

- <u>Abstract:</u> This paper presents a novel stereo fisheye event camera which offers a complete 360° perception of the surrounding environment. The emphasis is given on the design of the sensor and on the optical model. Finally, the omnidirectional camera is tested in an outdoor, challenging environments to detect and track a drone without a priori knowledge on its motion.
- Link: https://ieeexplore.ieee.org/document/11128164
- **Best Paper Award Finalist & Best Paper Award Finalist in the category Field and Service Robotics**

Submitted paper

(S1) **M. Robic**, F. Morbidi, P. Vasseur. "Kent-based Bayesian Estimation for Drone Tracking with a Spherical Event Camera", Submitted in *IEEE Transaction on Robotics (T-RO)* in December 2025.

(S2) N. Jabbari Tofighi, **M. Robic**, F. Morbidi, P. Vasseur. "A Survey on Event-based Optical Marker Systems", Submitted in *IEEE Robotics and Automation Magazine (RA-M)* in April 2025.

(S3) N. Jabbari Tofighi, **M. Robic**, J. Caracotte, F. Morbidi, P. Vasseur. "Event-based Optical Communication with Active Markers for Aerial Robots", Submitted in *IEEE International Conference on Robotics and Automation (ICRA)* in September 2025.

CONFERENCE INVITATIONS

- 2025: **IEEE International Conference on Robotics and Automation**, Atlanta, United States of America.
- 2022: **IEEE/RSJ International Conference on Intelligent Robots and Systems**, Kyoto, Japan.
- 2022: **International Astronautical Congress**, Paris, France.

REVIEW HISTORY

IEEE Transactions on Robotics

IEEE Transactions on Industrial Electronics

IEEE Robotic and Automation Letters

IEEE International Conference on Robotics and Automation

IEEE/RSJ International Conference on Intelligent Robots and Systems.

TEACHING, SUPERVISING, MENTORING ACTIVITIES

- 2024: **Supervision of 2 PhD students** and **one engineer** in the Research Expedition 3.

- 2021-2023: **Part-Time Lecturer in Control Engineering**, INSA, Rennes
  - Courses on Automatic Control, Logical System, Sequential System.
  - Project management on the Design of a Robotic Gripper.
  - Project management on the Programming of a Pick-Move-Place Robot.

PRIZES AND AWARDS

- 2025**: Best Paper Award Finalist & Best Paper Award Finalist in the category Field and Service Robotics** at IEEE International Conference on Robotics and Automation (ICRA'2025).
- 2025: **MSCA postdoctoral fellowship award**, a prestigious and highly competitive European grant, with a grade of 98/100 (top 7% in the category "ENGINEERING").
- 2022: **Winner of the 3rd Prize from the "My thesis in 180 seconds (MT180)" Jury**, a scientific outreach competition where doctoral students present their research in a very limited time. I finished 3rd ahead of 650 participants. Link to my 3-minutes presentation: https://youtu.be/O7Aewiscclk?si=iGkRQ6cCrN_NWxO8
- 2022: **Medal of the Academy**, awarded from the Academy of Rennes for exceptional achievement and academy representation.

INVITED TALKS

- 2024: **Scientific outreach for PhD**, *Inria, Rennes.* Intervention for a training session. ***Topic***: Scientific outreach.
- 2023: **Le + de l'info**, *France 3 Bretagne, Rennes.* Intervention in TV news. ***Topic***: Scientific outreach.
- 2023: **Pint of Science,** *Rennes.* Conference during an outreach event. ***Topic***: Earth observation satellites.
- 2023: **Immersion Science,** *Île-Tudy.* Conference for high-school students. ***Topic***: Earth observation satellites.
- 2023: **Innovation Day,** *DGA, Rennes.* Roundtable with experts in satellite chips. ***Topic:*** Space hardware.
- 2022: **La Méthode Scientifique**, *France Culture*, *Paris.* Radio interview. ***Topic:*** Scientific outreach.

PARTICIPATION TO INDUSTRIAL INNOVATION

- 2020-2023: **Scientific collaborator of the national project "BPI LiCHiE"** led by Airbus Defence & Space, aimed at developing new optical instruments and guidance strategies for high-precision remote sensing satellites. Expecting launching dates of the "LION" constellation: end of 2025. I am still in contact with the stakeholders for an in-orbit demonstration.
- 2023: **Speaker at DGA's Innovation Day**, a roundtable with experts in embedded systems for satellite, artificial intelligence, and French defense systems companies.

SELECTED SKILLS

Programming languages: C++/C, Python, Matlab, Java. **Robotic frameworks:** ViSP, OpenCV, ROS.

Optimization frameworks: ProxQP, qpOASES, (in progress) CasADi.

3D Modeling softwares: CATIA, Solidworks. **Video making/Drawing:** DaVinci Resolve, Inkscape, Gimp.

HOBBIES

Sports: Running (3x Marathons), Paddle tennis, Football.

Culture: Theater (amateur comedian in 6[+] representations).