Joel Oliveira Reis

Assistant Professor, University of Macau

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Languages

Native Portuguese speaker
Full professional proficiency in English
Basic knowledge of spoken and written Chinese

Programming and Software

Matlab, Python, C/C++, ROS, Git, Linux, SolidWorks, LaTeX

ORCID iD

Github

joelreis

WeChat

joelreis90

CV last updated on January 14, 2026

About me

I was born in 1990, in Fátima, Portugal. I received the M.Sc. degree in aerospace engineering from the Instituto Superior Técnico, Universidade de Lisboa, Lisbon, Portugal, in 2013, and the Ph.D. degree in electrical and computer engineering from the University of Macau, Macau, China, in 2019.

During my master's program, I worked on the conception, designing, development, and testing of a low-cost ultra-short baseline acoustic positioning system, later named PONTUS (POrtable Navigation Tool for Underwater Scenarios). This versatile device is designed for the localization of subsea targets. PONTUS can be mounted on a marine robotic vehicle or operated manually by a scuba diver. It features a graphical display that provides real-time data on the tracking of designated targets (see figure below).

(a) 3D Rendering in SolidWorks

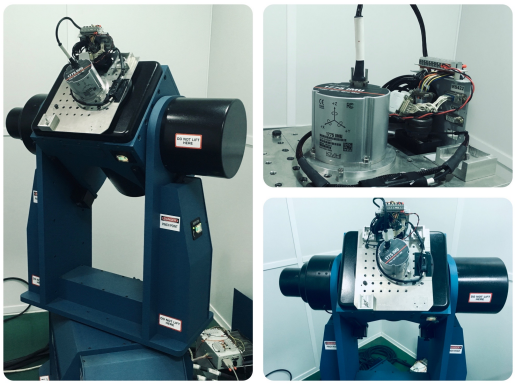
(b) Final prototype ready for tests

Ultra-short baseline acoustic positioning system PONTUS

I was involved in this project for about two years, during which I was directly responsible for implementing real-time applications. My work primarily focused on acoustic communications, digital signal processing using a C6713 DSP chip from Texas Instruments, inertial navigation architectures, and systems programming. Later, I prepared and conducted a series of experiments to validate and assess the performance of the developed prototype. These experiments also demonstrated the efficiency of novel localization and navigation algorithms that I developed during the initial stage of my Ph.D. at the University of Macau.

Still within the scope of underwater applications, my Ph.D. research branched into attitude estimation using high-grade gyroscopes sensitive to the Earth's spin. While localization answers the question *where are the targets?* and navigation answers *where am I?*, attitude estimation focuses on determining our orientation in space. This is crucial in challenging underwater environments where information is typically scarce and difficult to access. This research direction allowed me to work with state-of-the-art technology, including the KVH 1775 fiber optic rate gyro and the Ideal Aerosmith motion rate table (see figure below).

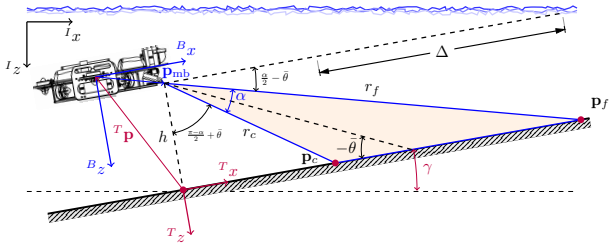
Currently, I am working with autonomous vehicles across aerial, surface, and underwater domains. My work primarily focuses on estimation and control theories applied to these vehicles in various application scenarios, including cases involving (potentially heterogeneous) multi-agent cooperation.



Attitude estimation setup: fiber optic gyroscope mounted on a rotating motion rate table.

One of these agents is ORVIS, an autonomous underwater vehicle (AUV) designed for shallow water bathymetric missions. This vehicle was fully developed in-house at the SCORE Laboratory of the University of Macau. The ORVIS AUV is equipped with a sensor suite that includes an Oculus M1200d multibeam imaging sonar, a Waterlinked A50 doppler velocity log, and a set of basic navigation sensors: a Microstrain 3DM-GX4-45 Inertial Measurement Unit, a GPS unit, a depth pressure sensor, and a sonar altimeter. The purpose of this cutting-edge research project is to develop advanced solutions for shallow water intervention tools that can be employed in Macau waters. These tools are intended for accurate shallow water bathymetry, inspection of underwater structures, studies of marine biodiversity, assessment of human impact on the marine environment, detection and localization of toxic spills, and more.

Following the designing and assembly of the ORVIS prototype, I have been entirely responsible for all aspects of its systems programming and sensor integration. In parallel with the vehicle's hardware and software development, I have also been working on new control algorithms using multibeam imaging sonar. The latest innovation involves a new intelligent bottom-tracking paradigm that exploits convenient geometrical relationships related to the sonar itself and the profile of the sea bottom (see figure below).



(a) Bottom-tracking setup

(b) ORVIS prototype

Recent contributions encompass state estimation and nonlinear control of quadrotors, including aerial cargo transportation, as well as nonlinear control of marine vessels (refer to **Publications** below). My expertise in the latter, combined with my knowledge of software frameworks for robots, was instrumental in leading the SCORE Laboratory team to victory in the First Zhuhai Wanshan International Intelligent Vessel Competition.

Most of my published works feature experimental validations with various sensors and different types of autonomous vehicles. Over the years, this has enabled me to acquire a broad knowledge of computer network management and electronic systems, including electrical connectors, welding, cabling, and mounting hardware.

To conclude this *About me* section, I am also an avid reader and cinephile.

Academic Positions

2024 – Jan – **Assistant Professor**
University of Macau
Department of Ocean Science and Technology

Education

2014 – 2019 **Doctor of Philosophy in Electrical and Computer Engineering**
Aug – Nov University of Macau
Dissertation: *Nonlinear Estimation Techniques for Underwater Localization and Positioning Solutions.*

2011 – 2013 **Master in Aerospace Engineering (Final grade: 17/20)**
Sep – Nov Instituto Superior Técnico, University of Lisbon
Thesis: *Advanced Signal Processing Aiding Techniques for Inertial Navigation Systems*

2008 – 2011 **Graduated Engineering Sciences - Aerospace Engineering (Final grade: 16/20)**
Sep – Jun Instituto Superior Técnico, University of Lisbon

2006 – 2008 **High School Diploma - Science and Technologies (Final grade: 18/20)**
Sep – Jul Centro de Estudos de Fátima, Portugal

Awards

2024 **IEEE Journal of Oceanic Engineering's Outstanding Reviewer**

2022 **FDCT Funding Scheme for Postdoctoral Researchers of Higher Education Institutions**
Macau, China
Awarded a post-doctoral fellowship for a period of 24 months.

2020 **First Zhuhai Wanshan International Intelligent Vessel Competition**
Zhuhai, China
Winner of Sailing Race Project - Development of a path following controller for an unmanned surface vessel.

2020 **Macau Science and Technology Development Fund (FDCT)**
Macau, China
Recipient of Scientific and Technological R&D Award for Postgraduates.

Research Positions

2022 – 2023 **University of Macau**

March – Dez Post-doctoral Fellow funded by the FDCT Funding Scheme for Postdoctoral Researchers of Higher Education Institutions of the UM Macao Talent Programme.

Period of two years dedicated to the practical development and testing of prototypes for autonomous aerial and underwater vehicles.

2019 – 2022 **Faculty of Science and Technology, University of Macau**

Dec – Mar Research Assistant.

Involved in UM Funded projects STEALTH (STate EstimAtion in Large neTworks with Heterogenous agents) and SECANTS (Self-triggered and Event-triggered Control of Autonomous NeTworked Systems, and in FDCT funded project SLOTMAV (Slung Load Transportation by Multiple Aerial Vehicles).

2012 – 2014 **Institute for Systems and Robotics, Lisbon**

Oct – Aug Fellow Researcher.

Worked in the Project MAST/AM: Advanced Tracking and Telemetry Methodologies to Study Marine Animals, which was funded by FCT —*Fundação para a Ciência e Tecnologia*. Main work consisted in programming a Digital Signal Processor C6713 from Texas Instruments that served as the backbone of an ultra-short baseline acoustic positioning system.

Professional service

Journal Reviewer

- ✍ IEEE Transactions on Automatic Control
- ✍ IEEE Transactions on Cybernetics
- ✍ IEEE Transactions on Systems, Man, and Cybernetics
- ✍ IEEE/ASME Transactions on Mechatronics
- ✍ IEEE Transactions on Aerospace and Electronic Systems
- ✍ IEEE Aerospace and Electronic Systems Magazine
- ✍ IEEE Transactions on Cognitive and Developmental Systems
- ✍ IEEE Sensors Journal
- ✍ IEEE Transactions on Instrumentation and Measurement
- ✍ Automatica
- ✍ Asian Journal of Control
- ✍ The International Journal of Robotic Research
- ✍ IEEE Journal of Oceanic Engineering
- ✍ Ocean Engineering

Conference Reviewer

- ✍ IEEE Conference on Decision and Control (CDC)
- ✍ IEEE American Control Conference (ACC)
- ✍ IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
- ✍ IEEE International Conference on Robotics and Automation (ICRA)

Publications

Papers in Journals

25. Weiming Yang, **Joel Reis**, Gan Yu, Linghuan Kong and Carlos Silvestre, “Trajectory Generation and Extended High-Gain Observer-Based Output Feedback Control for an Underactuated Flying Inverted Pendulum,” IEEE Transactions on Automation Science and Engineering, doi: 10.1109/TASE.2025.3649559.
24. Weiming Yang, **Joel Reis**, Gan Yu, and Carlos Silvestre, “Output feedback control of an underactuated flying inverted pendulum,” Control Engineering Practice, vol. 164, Elsevier BV, p. 106474, Nov. 2025.
23. Linghuan Kong, J. Reis, Wei He and Carlos Silvestre, ”Event-triggered prescribed-time tracking control for UAVs using polynomial error trajectories,” in IEEE Transactions on Automation Science and Engineering, vol. 22, pp. 16476-16486, May 2025
22. Yanhao Ju, **Joel Reis**, Yuangong Sun and Carlos Silvestre, “On the Asymptotic Stability of 2-D Linear Inhomogeneous Systems,” in IEEE Transactions on Automatic Control, vol. 70, no. 8, pp. 5546-5552, Aug. 2025.
21. **Joel Reis**, and Carlos Silvestre, “Kinematics-informed neural network control on SO(3),” Automatica, vol. 174, Elsevier BV, p. 112172, Apr. 2025.
20. Weiming Yang, Gan Yu, **Joel Reis**, and Carlos Silvestre, “Robust nonlinear 3D control of an inverted pendulum balanced on a quadrotor,” Automatica, vol. 159, Elsevier BV, p. 111336, Jan. 2024.
19. Linghuan Kong, **Joel Reis**, Wei He, Xinbo Yu, and Carlos Silvestre, “On dynamic performance control for a quadrotor-slung-load system with unknown load mass,” Automatica, vol. 162. Elsevier BV, p. 111516, Apr. 2024.
18. Weiming Yang, Gan Yu, **Joel Reis** and Carlos Silvestre, “Robust nonlinear 3D control of an inverted pendulum balanced on a quadrotor,” Automatica, vol. 159. Elsevier BV, p. 111336, Jan. 2024.
17. Linghuan Kong, **Joel Reis**, Wei He and Carlos Silvestre, “Experimental validation of a robust prescribed performance nonlinear controller for an unmanned aerial vehicle with unknown mass,” IEEE ASME Trans. Mechatron., vol. 29, no. 1, pp. 301–312, Feb. 2024.
16. Linghuan Kong, **Joel Reis**, Wei He and Carlos Silvestre, “Comprehensive Nonlinear Control Strategy for VTOL-UAVs With Windowed Output Constraints,” IEEE Transactions on Control Systems Technology, vol. 31, no. 6. Institute of Electrical and Electronics Engineers (IEEE), pp. 2673–2684, Nov. 2023.
15. **Joel Reis**, Gan Yu and Carlos Silvestre, “Kalman-based velocity-free trajectory tracking control of an underactuated aerial vehicle with unknown system dynamics,” Automatica, vol. 155. Elsevier BV, p. 111148, Sep. 2023.
14. Gan Yu, **Joel Reis**, David Cabecinhas, Rita Cunha and Carlos Silvestre, “Reduced-Complexity Active Disturbance Rejection Controller for Quadrotor-Slung-Load Transportation,” IEEE Transactions on Systems, Man, and Cybernetics: Systems, vol. 53, no. 8. Institute of Electrical and Electronics Engineers (IEEE), pp. 5248–5259, Aug. 2023.
13. **Joel Reis**, Pedro Batista, Paulo Oliveira and Carlos Silvestre, “Discrete-time Kalman filter for heave motion estimation,” Ocean Engineering, vol. 277. Elsevier BV, p. 114240, Jun. 2023.
12. Gan Yu, **Joel Reis** and Carlos Silvestre, “Quadrotor Neural Network Adaptive Control: Design and Experimental Validation,” in IEEE Robotics and Automation Letters, vol. 8, no. 5, pp. 2574-2581, May 2023.
11. **Joel Reis**, Wei Xie, David Cabecinhas and Carlos Silvestre, “Nonlinear Backstepping Controller for an Underactuated ASV With Model Parametric Uncertainty: Design and Experimental Validation,” in IEEE Transactions on Intelligent Vehicles, vol. 8, no. 3, pp. 2514-2526, March 2023.
10. **Joel Reis**, Gan Yu, David Cabecinhas and Carlos Silvestre, “High performance quadrotor slung load transportation with damped oscillations,” in International Journal of Robust and Nonlinear Control, 1–30, August 2022.

9. **Joel Reis**, Pedro Batista, Paulo Oliveira and Carlos Silvestre, “Earth Velocity and Rigid-Body Attitude Estimation on SO(3) Using Biased Measurements,” in IEEE/ASME Transactions on Mechatronics, vol. 27, no. 6, pp. 4246-4257, December 2022.
8. **Joel Reis**, Pedro Batista, Paulo Oliveira and Carlos Silvestre, “Attitude, body-fixed Earth rotation rate, and sensor bias estimation using single observations of direction of gravitational field,” in Automatica, Volume 125, 109475, March 2021.
7. Wei Xie, **Joel Reis**, David Cabecinhas and Carlos Silvestre, “Design and experimental validation of a nonlinear controller for underactuated surface vessels,” in Nonlinear Dynamics, 102, 2563–2581, November 2020.
6. **Joel Reis**, Pedro Batista, Paulo Oliveira and Carlos Silvestre, “Kalman Filter Cascade for Attitude Estimation on Rotating Earth,” in IEEE/ASME Transactions on Mechatronics, vol. 25, no. 1, pp. 327-338, February 2020.
5. **Joel Reis**, Pedro Batista, Paulo Oliveira and Carlos Silvestre, “Attitude estimation using high-grade gyroscopes,” in Control Engineering Practice, Volume 92, 104134, November 2019.
4. **Joel Reis**, Pedro Batista, Paulo Oliveira and Carlos Silvestre, “Calibration of High-Grade Inertial Measurement Units Using a Rate Table,” in IEEE Sensors Letters, vol. 3, no. 4, pp. 1-4, April 2019.
3. **Joel Reis**, Pedro Batista, Paulo Oliveira and Carlos Silvestre, “Nonlinear Observer on SO(3) for Attitude Estimation on Rotating Earth Using Single Vector Measurements,” in IEEE Control Systems Letters, vol. 3, no. 2, pp. 392-397, April 2019.
2. **Joel Reis**, Pedro Batista, Paulo Oliveira and Carlos Silvestre, “Source Localization Based on Acoustic Single Direction Measurements,” in IEEE Transactions on Aerospace and Electronic Systems, vol. 54, no. 6, pp. 2837-2852, December 2018.
1. **Joel Reis**, Marco Morgado, Pedro Batista, Paulo Oliveira and Carlos Silvestre, “Design and Experimental Validation of a USBL Underwater Acoustic Positioning System,” in Sensors, 16, 1491, September 2016.

Papers in Conferences

5. **Joel Reis** and Carlos Silvestre, “Kalman filter as observer and smoother for rigid-body motion control applications,” IFAC-PapersOnLine, vol. 58, no. 16, pp. 95-100, 2024.
4. Pedro Casau, **Joel Reis** and Carlos Silvestre, “Event-triggered trajectory tracking control of an underactuated autonomous surface vessel,” in 2022 American Control Conference (ACC), pp. 1757-1762, June 2022.
3. **Joel Reis**, Carlos Silvestre, Pedro Batista and Paulo Oliveira, “Attitude observers aided by implicit measurements of the Earth angular velocity,” in 59th IEEE Conference on Decision and Control (CDC), pp. 1300-1305, December 2020.
2. **Joel Reis**, Pedro Batista, Paulo Oliveira and Carlos Silvestre, “Nonlinear Attitude Observer on SO(3) Based on Single Body-Vector Measurements,” in 2018 IEEE Conference on Control Technology and Applications (CCTA), pp. 1319-1324, August 2018.
1. **Joel Reis**, Paulo Oliveira, Pedro Batista and Carlos Silvestre, “Filter design for localization aided by direction and Doppler measurements,” in 2014 IEEE International Conference on Robotics and Automation (ICRA), pp. 2957-2962, June 2014.

Projects

Following my PhD, I have been actively involved in the projects listed below, which encompass the fields of aerial robotics and marine robotics, the latter including surface and underwater environments. My role in these projects ranges from scientific research work to practical engineering, namely systems programming and implementation of navigation and control algorithms.

IMCIAV (FDCT Macau / NSFC China)

Project title: IMCIAV – Interaction Modeling and Control of Intelligent Autonomous Vehicles

Project reference: FDCT/0031/2020/AFJ

Financing Agency: University of Macau Funded by the FDCT - Fundo para o Desenvolvimento das Ciências e da Tecnologia, Macau, University of Science and Technology Beijing funded by the National Science Foundation China.
Initiated: September 22, 2020
Conclusion: September 21, 2023
Project description:

This research project focus on the two core issues of intelligent autonomous robots: Interacting Multiple Model and Control methods. Firstly, the objective is to construct dynamic models of autonomous robots with adaptability to the environment, using offline dynamic models and online system parameters obtained from the environmental information. Secondly, in order to improve the autonomy and robustness of the autonomous robots, we will study the control methods of the robots under the scenarios of constraint-unconstrained transformations. Further, taking the unmodelled environment into consideration, we will study interactive control strategies of for autonomous robots as to improve their intelligence and safety when they interact with the environment.

Finally, based on local sensing information, the distributed algorithms will be studied to complete the task of autonomous multi-agent cooperation and to be applied to practical scenarios such as autonomous robots navigating in complex urban environment. The scientific research teams from both University of Macau and University of Science and Technology Beijing will cooperate together to find feasible solutions to the key scientific problems of Interacting Multiple Model and Control methods and of Intelligent Autonomous Robots.

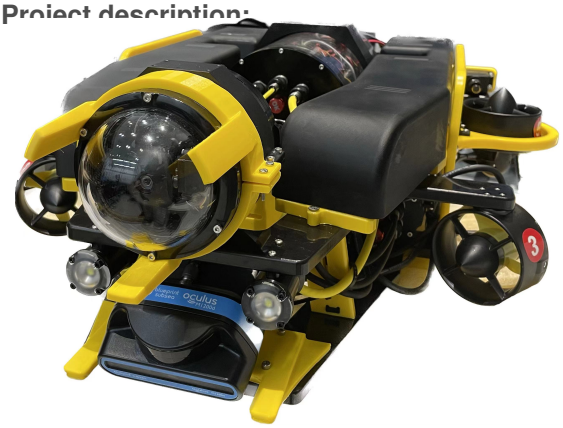
Project ORVIS (FDCT Macau)

Project title: ORVIS – Ocean Robotic Vehicles for Intervention in Shallow Waters
Project reference: FDCT/0146/2019/A3
Financing Agency: FDCT - Fundo para o Desenvolvimento das Ciências e da Tecnologia, Macau
Initiated: May 24, 2020
Conclusion: May 23, 2023
Project description: The purpose of this cutting edge research project is to set out advanced solutions to the development of shallow water intervention tools that can be employed, in Macau waters for accurate shallow water bathymetry, inspection of underwater structures, studies of marine biodiversity, assessment of the human impact on the marine environment, detection and localization of toxic spills, etc.

The key outcomes of the proposed research effort are fourfold: i) to conceive, develop, and test a Remotely Operated Vehicle, ORVIS ROV, and an Autonomous Underwater Vehicle, ORVIS AUV, for shallow water operations based on off-the-shelf affordable components; ii) to develop algorithms for high accuracy bathymetry and seabed mapping based on affordable multibeam imaging and doppler velocity log sonars; iii) to develop novel nonlinear trajectory tracking and path following controllers with bottom following and obstacle avoidance capabilities for marine vehicles to allow them to perform accurate bathymetry with full seabed coverage of the target areas in the presence of unexpected static or even dynamic obstacles; iv) to develop fault detection and isolation techniques as applied to marine vehicles, exploring new sensor, actuator or vehicle configurations.

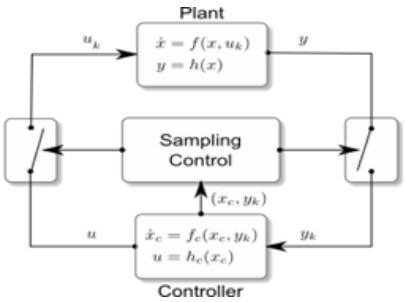
Project SECANTS (Level III MYRG R&DAO University of Macau)

Project title: SECANTS – Self-triggered and Event-triggered Control of Autonomous NeTworked Systems
Project reference: MYRG2018-00198-FST
Financing Agency: University of Macau
Initiated: January 1, 2019
Conclusion: December 31, 2021
Project description:



Prototype autonomous underwater vehicle developed in the University of Macau.

The goal of this project is the decentralized control of networked hybrid systems by means of advanced sampled-data feedback. Hybrid system models are specially tailored to describe physical systems that experience abrupt changes in the dynamics, thus they are particularly well-suited to represent the interconnection between physical systems and digital computers, referred to as sampled-data control.

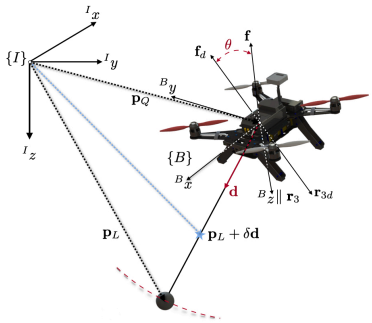


Standard design for sampled-data control systems relies typically on periodic sampling of both the input and the output of the plant. However, two non-periodic sampling control strategies have recently been proposed: event-based control and self-triggered control. This project will further develop these strategies by: i) making use of the hybrid systems modelling framework to define the overarching architecture of sampled-data control systems for continuous time plants (of which event-based control and self-triggered control are particular examples); and ii) extending the previous model to sampled-based control of a hybrid system and exploiting its application to the decentralized control of networked hybrid systems. The focus will be placed on finding conditions for completeness, non-Zenoness, stability and robustness of solutions to the closed-loop system, while optimizing for performance. The effectiveness of the new techniques will be demonstrated in the distributed control of modular aerial vehicles.

Project SLOTMAV (FDCT Macau)

Project title: SLOTMAV – Slung Load Transportation by Multiple Aerial Vehicles
Project reference: MYRG2018-00198-FST
Financing Agency: FDCT - Fundo para o Desenvolvimento das Ciências e da Tecnologia, Macau
Initiated: August 15, 2017
Conclusion: August 14, 2020
Project description: Technological developments are enabling autonomous Unmanned Aerial Vehicles (UAVs) to play an ever-increasing role as remote sensing platforms. In particular, a team of rotorcrafts equipped with cables connected to a slung load can work together to control and carry a platform on which a multitude of sensors can be installed. The multiple

rotorcraft configurations add redundancy and fail safety, allowing the mission to be carried out in crowded areas with total confidence and without endangering the public. Moreover, the carrying capacity and endurance of the mission are greatly increased, hence, opening the UAVs to a wide range of new tasks. The aims of this project are manifold: i) to conceive, develop, and test new advanced high performance control strategies for a single UAV carrying a slung load; ii) to conceive, develop, and test new advanced high performance control strategies for multiple UAVs carrying a load hanged by a single or multiple anchor points; and iii) to develop a team of UAVs and all the onboard real-time systems for load sensing, navigation, control, and mission control.



This is a fundamental step towards the goal of developing a failsafe, redundant, high performance and endurance multi-vehicle aerial platform that can be safely operated in many daily situations that include: media event coverage in crowded locations, like sportive events; deliver aid, including water and medical supplies to affected areas; and the operation of expensive sensor arrays in remote sensing applications. As final project output two operational setups are proposed, were the accuracy of the position and orientation of the load along the trajectory will be fundamental for its correct operation. These setups consist of: i) a demonstration of a coordinated load catch and release maneuver by a single or by multi-vehicle configurations; ii) a demonstration of the operation of a sensing array comprised of visible light and infrared cameras by multiple aerial vehicles. This project will boost the development of advanced, high performance, nonlinear control and load sensing algorithms that will improve the current level of autonomy of load carrying UAVs. Their real time onboard implementation will allow demonstrating the efficacy of the UAV team as an autonomous platform with enormous potential for carrying out remote sensing missions. Equipped with onboard advanced sensing and control systems, it will be fully shown how the collaborative UAV team can: i) be easily launched from a confined area; ii) carry the sensing platform to the site of interest; iii) make the sensing platform describe accurately the desired trajectory to maximize sensor performance; and iv) return to a safe place, all in autonomous mode and with appropriate fail safety and redundancy mechanisms. The experience acquired from both the UAVs and the installed equipment will pave the way for future installation of more sophisticated sensing equipment, thus providing end-users with safe and versatile sensing platforms supporting a multitude of missions in the fields of remote sensing, inspection, monitoring, media coverage, surveying, mapping and imaging.