



UNIVERSITÀ DEGLI STUDI DI NAPOLI
FEDERICO II

itee^{PhD}
information technology
electrical engineering



Andrea Capuozzo

Control of aerial-amphibious drones capable of flying and navigating

Tutor: Prof. Vincenzo Lippiello

Cycle: XXXIX

Year: 2024/2025

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information technology
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Background

- M.Sc. in **Automation & Robotics Engineering** - Università degli studi di Napoli Federico II
- Research group: **Aerial robotics @ PRISMA Lab**
- PhD start date: 1st November 2023
- Scholarship type: PNRR - Centro Nazionale CN 5 – National Biodiversity Future Centre

Summary of study activities

- **Courses**

- *How to Boost Your PhD* - Prof. Antigone Marino, ITEE PhD
- *Innovation and Entrepreneurship* - Prof. Pierluigi Rippa. ITEE PhD

- **Conference attended**

- *International Conference on Unmanned Aircraft Systems – ICUAS 25*, Charlotte, NC, USA, May 14-17, 2025

- **Tutorship**

- *Teaching assistant for Robotics Lab course of M.Sc. In Automation & Robotics Engineering*, a.y. 2024/2025 Prof. Mario Selvaggio

Research products

[C1]	Andrea Capuozzo , Fabio Ruggero, Vincenzo Lippiello <i>Heave Motion Estimation from IMU measurement in Hybrid Aerial-Amphibious Drones and Horizontal Take-Off Window prediction</i> International conference on Unmanned Aircraft Systems – ICUAS 25
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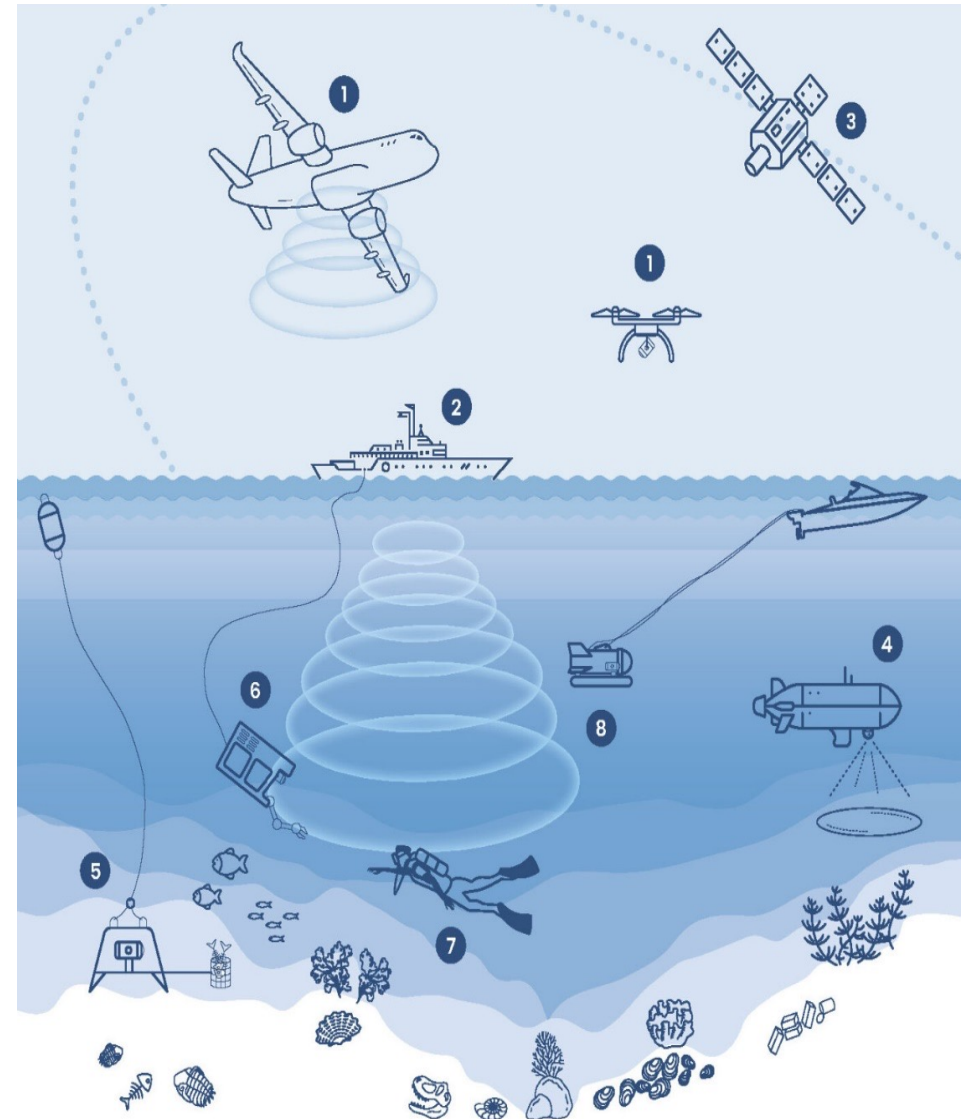
Research area

- **Objective**

Develop a fast, low cost and safe tool for mapping and monitoring marine biodiversity

- **Why amphibious drones?**

- Fast and agile
- Cost effective
- Useful for hard-to-reach or dangerous environments
- Rapid deployment
- Reduced environmental impact



Research results

Porto Cesareo *Gongolaria Barbata* Study



DJI Matrice 300 RTK



Parrot Sequoia
Multispectral Camera

Mission parameters

70 m altitude

130000 m²

1,9 cm/px resolution

50k+ photos



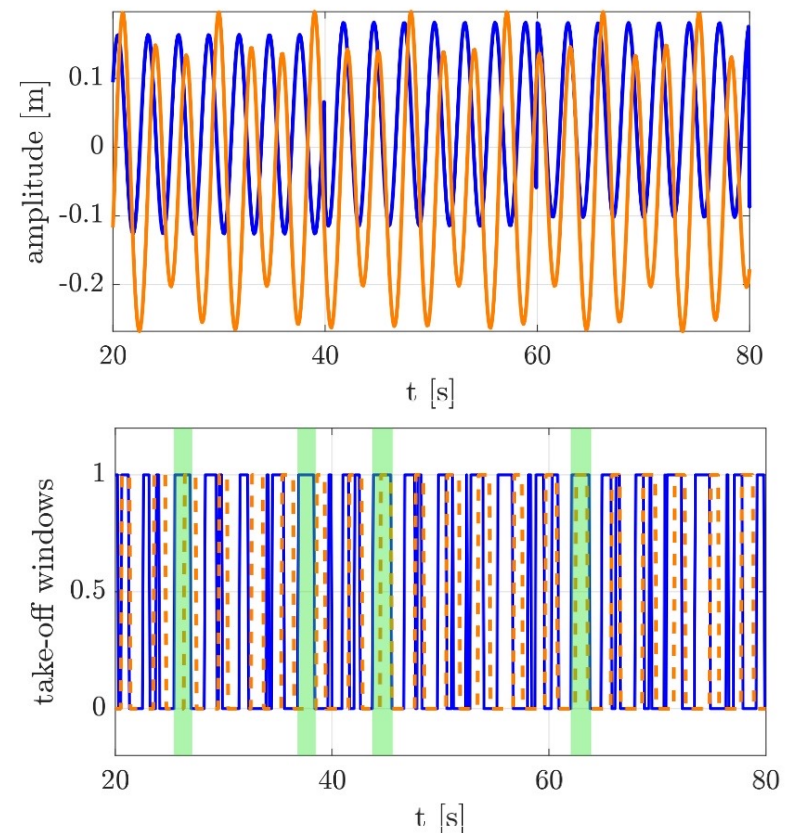
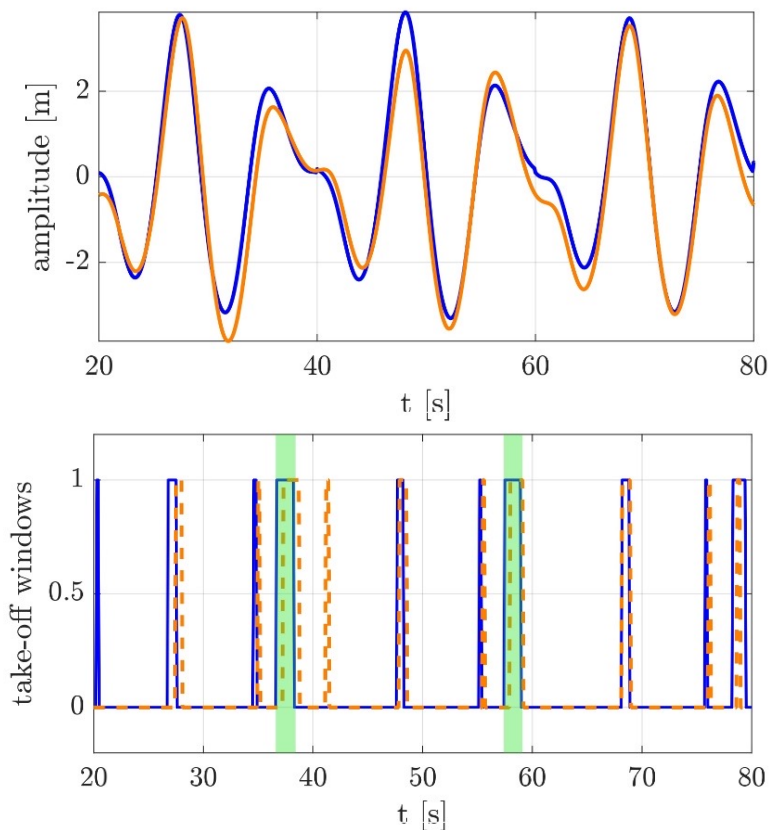
July 2024

October 2024

July 2025

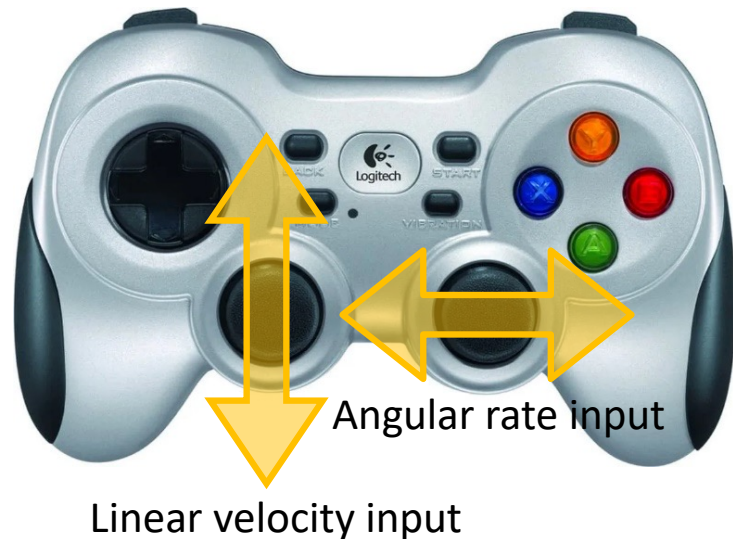
Research results

- **Completed takeoff algorithm in presence of sea waves**
 - FFT-based prediction of time windows in which the drone has a level attitude and the propeller-water distance is maximized
 - Promising performances for up to 3 long-period incident waves
 - Needs improvement for short-period high amplitude-waves



Research results

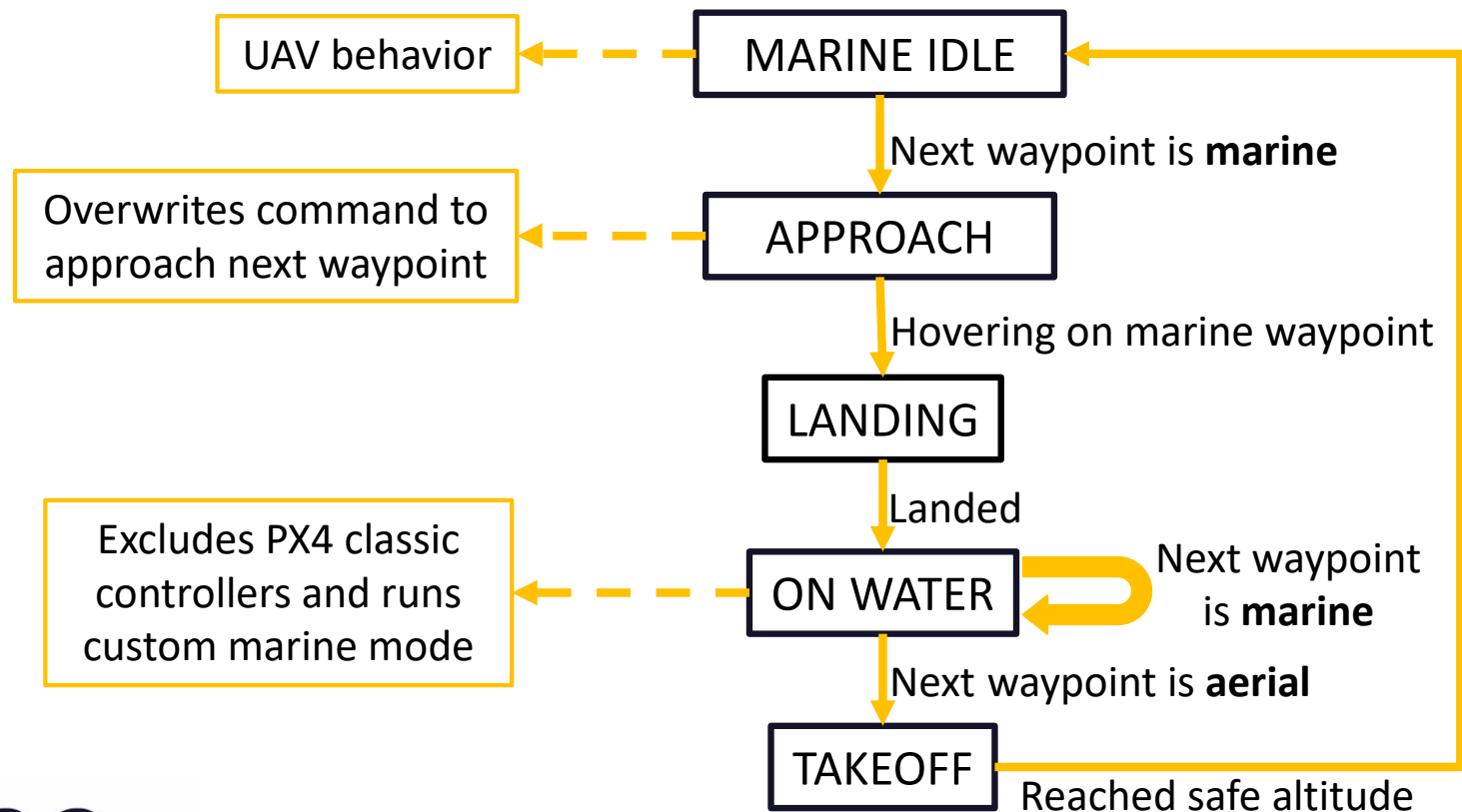
- **PX4 manual control algorithm for hybrid aerial-amphibious drones**
 - Linear velocity and angular rate control
 - Accounts for hydrodynamic effects
 - Quaternion based
 - Safe switch between aerial and marine navigation



Research results

- **PX4 autonomous hybrid aerial-marine mission mode**
 - Built as a state machine
 - Recognize aerial and marine waypoint
 - Manages water takeoff and landing
 - Manages autonomous surface navigation and trajectory planning (in progress...)

Custom PX4 mission mode manager



Next Year

- Finalization of PX4 firmware for hybrid aerial-amphibious drones
- Amphibious drone testing in confined waters and in the open sea
- **Period abroad @ IRISA/Inria:** Developing a mission planner that computes optimal trajectories for marine survey missions
- Conducting aerial and marine monitoring missions with the new drone in Porto Cesareo

The final product

