



UNIVERSITÀ DEGLI STUDI DI NAPOLI
FEDERICO II

itee^{PhD}
information technology
electrical engineering



Vincenzo Scognamiglio

Autonomous Navigation in GPS-denied Environment

Tutor: Prof. Vincenzo Lippiello

co-Tutor: Eng. Alessandro Massa (Leonardo S.p.A.)

Cycle: XXXVII

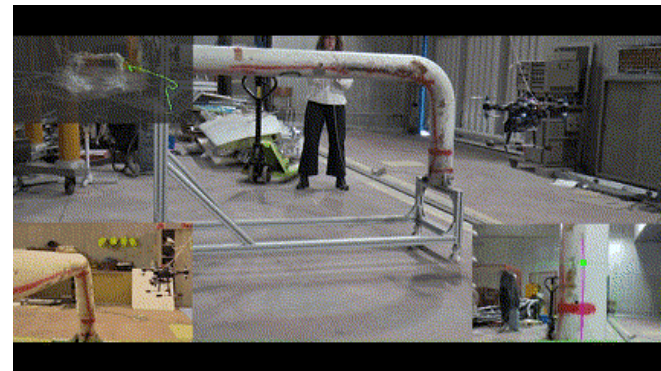
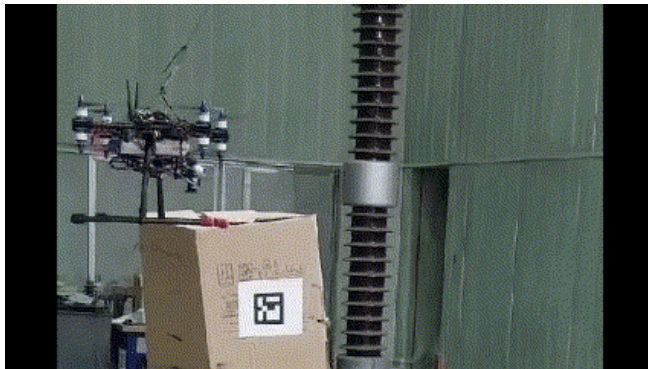
Year: Second

My background

- M.Sc. in Automation Engineering, Università degli Studi di Napoli Federico II (Sep 2021)
- Group: Aerial Robotics of Prisma Lab
- PhD Start Date: 1st November 2021
- Scholarship Type: Company-funded
- Partner Company: Leonardo S.p.A.

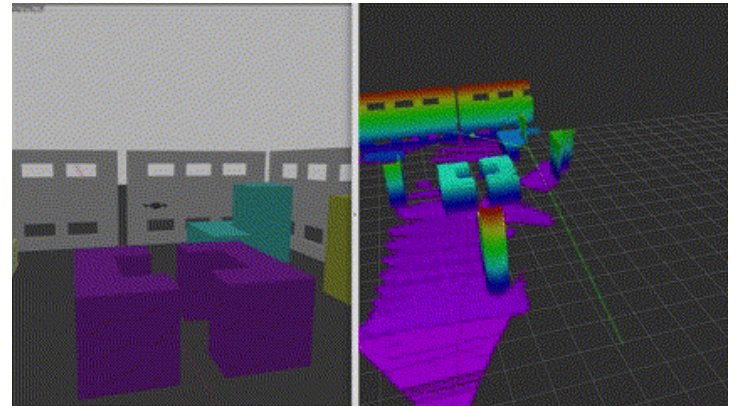
Research field of interest

- **Objective:** Develop a navigation framework to allow mobile robots to navigate fully autonomous in GPS-denied environment.
- **Why:** In most application where robots are implemented, they cannot have access to GPS-signal.
- **Applications:** Operations of exploration and inspection of unknown environments.



Research field of interest

- Assuming that the environment is unknown and without GPS signal, robots have to explore to accomplish defined tasks
- Perceiving what they are surrounded by is mandatory to plan movements for navigation purposes.
- Computing a robust estimation of robot's absolute position is fundamental for stable movements.
- Everything have to occur simultaneous to achieve safe and efficient exploration.



Summary of study activities

- Ad hoc PhD courses / schools:
 - ***"Robotics Lab"***, Lecturer: Prof. J. Cacace, MSc Degree in Automazione e Robotica at University of Naples "Federico II": the course focuses on the practical implementation of robotics framework using simulators and ROS middleware.
 - ***"Field and Services Robotics"***, Lecturer: Prof. F. Ruggiero, MSc Degree in Automazione e Robotica at University of Naples "Federico II": this course aims to provide an overview of the tools employed to model, plan, and control wheeled robots, unmanned aerial and underwater vehicles, and legged robots.
- Conferences / events attended:
 - ***"Leonardo Drone Contest"***, Organizer: Leonardo S.p.A., Torino: Contest between seven Italian universities, the goal was to fly with a multi-robot system composed by a drone and a rover in a city-like scenario without GPS-signal.

Research activity: Heterogeneous Multi-Robot System

- Problem

Autonomous exploration of a semi-unknown environment using a team of heterogeneous mobile robots

- Objective

To develop a complete multi-robot system composed by a drone, a rover and a PTZ camera. They must explore an indoor city-like scenario and find Interesting Points (IPs) without using GPS.



- Methodology

- High level task planner
- 2D and 3D SLAM
- Low level motion planner with obstacle avoidance

Research activity: Heterogeneous Map Fusion

- Problem

A ground robot and an aerial robot, equipped with different kind of sensors, have to explore an environment sharing spatial knowledge
- Objective

To refine a global map fusing heterogeneous informations from the two robots
- Methodology
 - Geometric features detection
 - Data association
 - Probabilitstic map update

Products

| | |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| [C1] | <i>S. Roos-Hoefgeest, J. Cacace, V. Scognamiglio, I. Álvarez, R. C. González, F. Ruggiero, V. Lippiello, "A Vision-based Approach for Unmanned Aerial Vehicles to Track Industrial Pipes for Inspection Tasks," 2023 International Conference on Unmanned Aircraft Systems (ICUAS), Warsaw, Poland, 2023, pp. 1183-1190, doi: 10.1109/ICUAS57906.2023.10156565.</i> |
| [J1] | <i>J. Cacace, V. Scognamiglio, F. Ruggiero, V. Lippiello, "Motor Fault Detection and Isolation for Multi-Rotor UAVs Based on External Wrench Estimation and Recurrent Deep Neural Network", Journal of Intelligent & Robotic Systems, Currently under review</i> |

- **Tutorship:**

Lecturer assistant: "Mobile Robots" by prof. F. Ruggiero and J. Cacace, MSc Degree in Autonomous Vehicles

Next Year

- Explore the abilities of an heterogeneous multi-robot system:
 - Global map refinement
 - Cooperative mapping and localization
- Keep studying on robustify self localization of robots
- Study SLAM in particular conditions (such as interaction with the environment, presence of dust, light conditions)
- Plan activities for the period abroad