PhD in Information Technology and Electrical Engineering
Università degli Studi di Napoli Federico II

PhD Student: Salvatore Marcellini

Cycle: XXXVI

Training and Research Activities Report

Academic year: 2021-2022 – PhD Year: Second

Salvatore Marcellini

Tutor: prof. Vincenzo Lippiello

Co-Tutor:

Date: 31 October, 2022

_____

1. Information:

- **PhD student:** Salvatore Marcellini   **PhD Cycle:** XXXVI
- **DR number:** DR995142
- **Date of birth:** 16/07/1994
- **Master Science degree:** Automation Engineering   **University:** Federico II
- **Scholarship type:** Funding company (Leonardo)
- **Tutor:** Prof. Vincenzo Lippiello
- **Co-tutor:**

2. Study and training activities:

Activity	Type[1]	Hours	Credits	Dates	Organizer	Certificate[2]
Imprenditorialità accademica	Course	9.5	4.0	26.05.2022 – 14.06.2022	Università di Napoli Federico II	Y
IEEE RAS Summer school on multirobot system	Summer School	50	2.0	01.08.2022 – 06.08.2022	CZECH Technical University in Prague	Y
Neural Networks and Deep Learning	Course	39	6.0	20.10.2022	TeCIP, Scuola Superiore Sant'Anna	Y
Coverage control for robotic swarms: Heterogeneity, Learning, and Artistic Expression	Seminar	1.5	0.3	03.12.2021	RAS Bolivia Chapter	Y
Adaptive and learning controllers for high accuracy trajectory tracking in changing environments	Seminar	1,5	0.3	15.12.2021	RAS Bolivia Chapter	Y
Cyber security in Akka Technologies	Seminar	2.0	0.4	03.11.2021	Università di Napoli Federico II	Y
Vehicular Hacking in Akka Technologies	Seminar	1.5	0.3	03.11.2021	Università di Napoli Federico II	Y
	Seminar	6.0	1.2			Y

				07.12.2021	Workshop of 20th International Conference on Advanced Robotics	
Design, Learning, and Control for Safe Human-Robot Collaboration				07.12.2021	Workshop of 20th International Conference on Advanced Robotics	
Swetaly workshop on the theme of AI	Seminar	4	0.8	20.01.2022	Örebro University, Gothenburg University	Y
Evento Osservatori Digital Innovation: Workshop di Kick-off Osservatorio Droni	Seminar	2.5	0.5	21.04.2022	Politecnico di Milano	Y
IEEE Authorship and Open Access Symposium: Tips and Best Practices to Get Published from IEEE	Seminar	1	0.2	30.03.2022	IEEE Authorship and Open Access	Y
On using simple optimization techniques for tuning UAVs	Seminar	2	0.4	27.04.2022	University of Naples Federico II	Y
Workshop: Shared Autonomy in Physical Human-Robot Interaction: Adaptability and Trust	Seminar	8	1.6	23.05.2022	ICRA 2022	Y
Vine robots: design challenges and unique opportunities	Seminar	1	0.2	31.05.2022	Università di Napoli Federico II	Y
PX4 Developer Summit	Seminar	16	3.2	23.06.2022 - 24.06.2022	Dronecode Foundation	Y
Study and implementation of an NMPC for autonomous inspection with UAV	Research		7.5			N
Study of intruder research with autonomous UAV	Research		9.2			N

Training and Research Activities Report
PhD in Information Technology and Electrical Engineering

Cycle: XXXVl   **Author:** Salvatore Marcellini
_____

Study of an NMPC for repetitive recognition	Research		8.1			N
Implementation of an NMPC for repetitive recognition	Research		6.0			N
Writing a paper about repetitive reconnaissance with autonomous drone	Research		4.0			N
Study and implementation of the controlo for omnidirectional drones with PX4	Research		4.0			N

1) Courses, Seminar, Doctoral School, Research, Tutorship
2) Choose: Y or N

2.1. Study and training activities - credits earned

	Courses	Seminars	Research	Tutorship	Total
Bimonth 1	0,00	2,50	7,50	0,00	10,00
Bimonth 2	0,00	0,80	9,20	0,00	10,00
Bimonth 3	0,00	1,10	8,10	0,80	10,00
Bimonth 4	0,00	5,00	6,00	0,80	11,80
Bimonth 5	6,00	0,00	4,00	0,00	10,00
Bimonth 6	6,00	0,00	4,00	0,00	10,00
Total	12,00	9,40	38,80	1,60	61,80
Expected	**10 - 20**	**5 – 10**	**30 – 45**	**0 – 1.6**	**45 – 76.6**

3. Research activity:

The PhD scholarship is associated with the "Leonardo Drone Contest", a challenge between six Italian universities aiming to develop a framework for autonomous drones that work in indoor and GPS-denied environments, pooling university and business resources and knowledge.

This year, the research activity has been focused on the repetitive reconnaissance mission, in which a single multirotor drone must survey a given map by repetitively visiting several checkpoints. Possible applications are related to the research of intruders, gas leaks, and so on. Several points of interest discretise the map: a time-varying probability is associated with each of them. Such a probability strictly depends on the application (e.g., a probability related to the intruder's presence or gas leak).

The proposed solution considers a nonlinear model predictive control approach that minimises the map's overall probability and considers several constraints related to the drone's dynamics and the environment (e.g., the presence of obstacles).

This solution has been tested both in simulation and inside the flight arena on a real drone, showing promising results for the repetitive recognition and the evaluation of smooth trajectories.

During this year, the work has also focused on implementing the control for tilting drones in the PX4 firmware. Firstly, we have modified the output allocation structure to control an H-shaped drone with tilting rotors. This mechanism allows the drone to fly forward without changing its orientation. For an omnidirectional tilting drone, instead, we added a new module to compute the allocation matrix and allocate the actuators' controls.

4. Research products

Submitted a paper to the conference ICRA 2023:

- S. Marcellini, F. Ruggiero, V. Lippiello, "*Nonlinear Model Predictive Control for Repetitive Area Reconnaissance with a Multirotor Drone*", submitted to the 2023 International Conference on Robotics and Automation, London, GB.

5. Conferences and seminars attended

6. Activity abroad

Summer school at CZECH Technical University in Prague

7. Tutorship

Tutor for the course of "Robotics Lab", teached by Dr. Jonathan Cacace.

Co-supervisor of 2 master students in Automation Engineering and 1 bachelor student in Automation Engineering.