



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

PhD Student: D'Angelo Simone

Cycle: XXXVII

Training and Research Activities Report

Year: First

Simone D'Angelo

Tutor: prof. Bruno Siciliano

Bruno Siciliano

Co-Tutor:

Date: October 31, 2022

Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle: XXXVII

Author: Simone D'Angelo

1. Information:

- **PhD student:** D'Angelo Simone
- **DR number:** DR995858
- **Date of birth:** 01/07/1996
- **Master Science degree:** Automation Engineering **University:** Federico II of Naples
- **Doctoral Cycle:** XXXVII
- **Scholarship type:** DIETI
- **Tutor:** Bruno Siciliano
- **Co-tutor:**

2. Study and training activities:

Activity	Type ¹	Hours	Credits	Dates	Organizer	Certificate ²
The era of Human-Robot Collaboration: Deep Sea Exploration	Seminar	2	0.4	6/12/2021	Prof. Siciliano & Prof. Khatib	Y
ICAR 2021 Workshop on Design, Learning and Control for Sage Human-Robot Collaboration	Seminar	6	1.2	7/12/2021	Mario Selvaggio, Gennaro Notomista, Valeria Villani and Kelly Merckaert	Y
- Study on already published works about aerial manipulation and tilting UAVs - Study on PX4-autopilot firmware for PixHawk - Reworking PX4 firmware to directly command the drones via thrust and torques command - Tests in simulations and on the real hardware - Laboratory activity	Research		8.4	From 1/11/21 To 31/12/21		
Strumenti Digitali e Robotici per l'Inclusione	Seminar	2	0.4	14/01/22	Prof. Bruno Siciliano	Y
Intelligenza artificiale	Seminar	2	0.4	19/01/22	Diego	N

Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle: XXXVII

Author: Simone D'Angelo

e sistemi d'arma autonomi					Latella, Guglielmo Tamburrini, Giuliano Colombetti and Fosca Giannotti	
Evento ENEL	Seminar	1	0,2	01/02/22	Prof. Domenico Cotroneo	Y
- Study on already published works about visual servoing - Laboratory activity - Tests in Flight Arena on real hardware and OptiTrack - Study on Acados library to implement Non-Linear Model Predictive Control algorithms - Study on OpenCV & Visp libraries to perform image elaboration and object recognition in a simulated environment	Research		9.0	From 1/01/22 To 31/02/22		
An Introduction to Deep Learning for Natural Language Processing	Seminar	1	0,2	13/04/22	Prof. Cutugno	Y
Explainable Natural Language Inference	Seminar	1,5	0,3	13/04/22	Prof. Cutugno	Y
Global and Cluster Synchronization in Complex networks and beyond	Seminar	1	0.2	10/03/22	SSM, Dr. Coraggio	Y
IEEE Authorship and Open Access Symposium: Tips and Best Practices to get published from IEEE Editors	Seminar	1.5	0.3	30/03/22	Rachel Berrington Director	Y
On using simple optimization	Seminar	2	0.4	27/04/22	Prof. Ruggiero	Y

Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle: XXXVII

Author: Simone D'Angelo

techniques for tuning UAVs						
- Study on already published works about UAVs control - Laboratory activity - Tests in Flight Arena on real hardware and OptiTrack	Research		6.6	From 1/03/22 To 31/04/22		
Matrix Analysis for Signal Processing with MATLAB examples	Course	8	2	22-23/03/22 5-7/04/22	Prof. Carotenuto	Y
Vine robots: design and unique opportunities	Seminar	1	0.2	31/05/22	Mario Selvaggio	Y
ICRA Workshop 2022: Shared Autonomy in Physical Human Robot Interaction Adaptability and Trust	Seminar	8	1.6	23/5/22	Mario Selvaggio, Jessie Yang, Luka Peternel, Laurel Riek, Elizabeth K Phillips	Y
- Laboratory activity - Tests in Flight Arena on real hardware Study on image elaboration with C++ libraries and simulation in Gazebo - Study on already published works about UAVs control	Research		4.2	From 1/05/22 To 31/06/22		
Statistical data analysis for science and engineering research	Course	12	4	22-24-29-31/03/22 5-7/04/22	Prof. Pietrantuono	Y
Imprenditorialità Accademica	Course	9.5	4	26/05/22 13-14-20/6/22	P. Rippa	Y
- Laboratory activity - Study on Direct Force Control and	Research		4	From 1/07/22 To		

Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle: XXXVII

Author: Simone D'Angelo

Hybrid Position-Force Control - Study on already published works on UAVs control - Study on already published works on interaction control				31/08/22		
IEEE RAS Summer School on Multi Robot Systems in Prague	PhD School	50	2	1-5/08/22	Prof. Saska	Y
Methods for Artificial Intelligence	Course	48	0	From 7/3/22 To 10/6/22	Prof. Rossi	N
Control of Complex Systems and Networks	Course	48	6	From 7/3/22 To 10/6/22	Prof. De Lellis	Y
Operational Research: Mathematical Modelling, Methods and Software Tools for Optimization Problems	Course	12	4	14-21-28/09 - 05-12/10/2022	Adriano Masone	Y
Laboratory Activity	Research		0	From 1/9/22 To 31/10/22		

- 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	1,6	8,4	0	10
Bimonth 2	0	1	9	0	10
Bimonth 3	2	1,4	6,6	0	10
Bimonth 4	4	1,8	4,2	0	10
Bimonth 5	6	0	4	0	10
Bimonth 6	10	0	0	0	10
Total	22	5,8	32,2	0	60
Expected	30 - 70	10 - 30	80 - 140	0 - 4.8	

Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle: XXXVII

Author: Simone D'Angelo

3. Research activity:

The conducted research topic concerns the study of interaction control with the environment of aerial manipulators. We have studied both the use of flat and tilting platforms. The current goal of the research is to merge interaction control with visual control. The objective is to use visual and interaction force feedback to complete inspection tasks in hard-to-reach places in an industrial environment.

During the first phase of the work, the current state of the art has been revised. First, the control of omnidirectional drones and aerial manipulators has been examined to get to work closer to the topics described above. We identified some works to use as a starting point. The current work tries to replicate the results obtained in past papers and expand the work already done by introducing some novelties.

At the same time, the Pixhawk family of flight controllers has been deeply studied. First, we understood their control architecture. Then, we tried to modify the firmware and adapt it to our needs using MATLAB toolboxes that allowed interfacing. In this way, in the first month of the PhD program, we implemented an admittance control on one of our platforms to autonomously complete the insertion of bird diverters on high-voltage power lines. The force feedback measures obtained by a load cell trigger the admittance filter modifying the reference trajectory during the interactions with the cables.

Furthermore, the thesis work can be expanded and completed by adding an interaction control to the architecture already implemented during the internship period. During the master thesis project, the control of a snake-like robot mounted on a wheeled rover was carried out. We implemented a motion controller with obstacle avoidance and an optimization method to stabilize a rover on a pipe. Now, this hyper-redundant robot is controlled with a hybrid force-motion control to achieve both trajectory tracking and force tracking using a sensor on the end-effector.

Regarding this last work, we also produced a scientific paper submitted to the IEEE Robotics and Automation Letters (RA-L) journal.

One of the best experiences of this first year was the Multi-Robot Systems Summer School in Prague. It was an opportunity to connect and exchange ideas with researchers from all over the world. We could also interact with the Czech Technical University aerial robotics team and professor M. Saska. At the end of the summer school, we also produced a small demo with the assigned team: we controlled two drones to inspect an area finding some features with a camera sensor. The inspection is performed by planning a trajectory to avoid collision between drones.

In the end, the current work is focused on parallel visual and interaction control. We will test the architecture first in a simulated environment. If the results are encouraging, we will move to real hardware.

4. Research products:

Scientific paper: **Stabilization and Control on a Pipe of a Wheeled Mobile Manipulator with a Snake-like Arm.**

Authors: **Simone D'Angelo, Antonio Corrado, Fabio Ruggiero, Jonathan Cacace, Vincenzo Lippiello.**

Journal: ***IEEE Robotics and Automation Letters (RA-L).***

Current state: **submitted.**

Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle: XXXVII

Author: Simone D'Angelo

5. Conferences and seminars attended

6. Activity abroad:

7. Tutorship