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

Year: First

Salvatore Marcellini

Tutor: prof. Vincenzo Lippiello

Vincenzo Lippiello

Co-Tutor:

Date: October 19, 2021

Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle: XXXVI **Author:** Salvatore Marcellini

1. Information:

- **PhD student:** Salvatore Marcellini
- **DR number:** DR995142
- **Date of birth:** 16/07/1994
- **Master Science degree:** Automation Engineering **University:** Federico II
- **Doctoral Cycle:** XXXVI
- **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]
Modeling Complex Systems	Course	26	6.0	9.11.2020 – 16.12.2020	Scuola Superiore Meridionale	Y
Short course on Deep Learning and Computer Vision for Autonomous Systems – Focus on drone vision, imaging, surveillance and cinematography	Online Course	17	1.5	18.11.2020 – 19.11.2020	Aristotle University of Thessaloniki	Y
Scientific Programming and Visualization with Python	Course	18	3.0	08.03.2021 – 10.03.2021	Università di Napoli Federico II	Y
Statistical data analysis for science and engineering research	Course	12	4.0	17-19-24-25/02/03-04/03/2021	Università di Napoli Federico II	Y
Robotics Lab	Course	II Semester	6.0	11/03/2021- 26/05/2021	Università di Napoli Federico II	Y
Strategic Orientation for STEM Research & Writing	Course	18	3.6	16.07.2021 – 17.10.2021	Università di Napoli Federico II	N
Patent Searching Best Practices with IEEE Xplore	Seminar	1	0.2	27.11.2020	IEEE	Y
How to Get Published with the IEEE	Seminar	1,5	0.3	02.12.2020	IEEE	Y

Network Systems, Kuramoto Oscillators, and Synchronous Power Flow	Seminar	1.5	0.3	03.12.2020	Scuola Superiore Meridionale	Y
Robot Manipulation and Control	Seminar	2.5	0.5	17.11.2020	Università di Napoli Federico II	Y
Advances in Machine Learning for Modeling and Understanding in Earth Sciences	Seminar	1.5	0.3	27.01.2021	IEEE Geoscience and Remote Sensing South Italy Chapter, chaired by Prof. Antonio Iodice	Y
Quadruped Robotics on the Rise	Seminar	2	0.4	0.4.02.2021	IFRR, moderated by Prof. Marco Hutter	Y
The coming revolution of Data driven Discovery	Seminar	1.5	0.3	25.03.2021	Scuola Superiore Meridionale	Y
Artificial Intelligence and 5G combined with holographic technology: a new perspective for remote health monitoring	Seminar	2	0.4	27.04.2021	5G Academy's, Prof. Antonia Maria Tulino	Y
Modelling the Complexity of Multiagent Activity for Human-AI Interaction using Dynamical Primitives	Seminar	1.5	0.3	06.05.2021	Scuola Superiore Meridionale	Y
Introduction to Underwater robotics	Seminar	2	0.4	18.05.2021	Università di Napoli Federico II	Y
SAR Polarimetry: Theory, Machine Learning & Applications	Seminar	2	0.4	19.10.2021	Università di Napoli Federico II	Y

Localized least-squares radial basis function methods for PDEs,	Seminar	1	0.2	14.10.2021	Università di Napoli Federico II	Y
Online event: "Artificial Intelligence Between Research and Industry"	Research	2	0.4	07.12.2020	University of Glasgow	Y
Online event: "Science, Reality and Credibility. Il ruolo del pensiero scientifico"	Research	2.5	0.5	29..11.2020	Città della Scienza – Futuro Remoto	Y

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	1,50	1,30	7,20	0,00	10,0
Bimonth 2	6,00	0,70	3,30	0,00	10,0
Bimonth 3	7,00	0,70	2,30	0,00	10,0
Bimonth 4	6,00	0,70	3,30	0,00	10,0
Bimonth 5	0,00	0,00	3,00	0,00	3,0
Bimonth 6	3,60	0,60	12,80	0,00	17
Total	24,10	4,00	31,90	0,00	60,00
Expected	**30 - 70**	**10 - 30**	**80 - 140**	**0 – 4.8**	

3. Research activity:

My scholarship is associated with the "Leonardo Drone Contest", that is a challenge between six Italian universities which aims to develop an autonomous driving system for drones, pooling university and business resources and knowledge.
My research activity focuses on the development of an autonomous drone that works in indoor/GPS denied environment.

This year my research activity has been focused on the development of a Nonlinear Model Predictive Control (NMPC) for the research of an intruder inside a known indoor environment. The control takes in account the dynamic of the drone, the constraints on the movements and the presence of the obstacles to compute a research trajectory, optimizing a cost function that is based on the estimation of the presence of the intruder. The estimation is evaluated on a time variant heat grid-map, where the heat represents the probability of finding an intruder inside a specific cell of the map. The heat of each cell changes during the time depending on the position of the drone, the paths followed and, eventually, the probable speed of the intruder.

During this year I have also worked on the hardware and software for the drone of the challenge.
First, I've developed a more robust program to measure the odometry with the Intel Realsense T265. This program works with two T265 mounted in different positions and orientations on the drone, switching between them in order to use always the best measurement. The switching policy is based on the covariance matrices of each sensor

and when it reaches a critical value, the calibration matrix is changed to delete the drift or the errors on the measurements.
Then I've programmed the state machine that controls the drone throughout the entire task. During the intruder research, the odometry is corrected when a known Aruco marker inside the map is recognized, but if the marker has an unknown id, the drone will perform a visual servoing on that target in order to acquire a good picture of the marker and the string below it. The string contains the information about the landing sequence to perform on the known landing areas associated to the known markers. The land on a desired marker is performed with a visual servoing on the 2D plane while the landing velocity is changed considering the distance from the center of the marker.

My research activity has been focused also on the control of an omnidirectional drone with tilting rotors and the implementation on a real drone, modifying the PX4 firmware.

4. Research products

5. Conferences and seminars attended

6. Activity abroad

7. Tutorship

Co-supervisor of the thesis of 2 master students in Ingegneria dell'Automazione