NIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

DOTTORATO DI RICERCA / PHD PROGRAM IN
INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING

Activities and Publications Report

PhD Student: Francesca Pagano

Student DR number: DR996115

PhD Cycle: XXXVII
PhD Cycle Chairman: Prof. Stefano Russo

PhD program student's start date: 01/01/2022
PhD program student's end date: 31/12/2024

Supervisor: Prof. Vincenzo Lippiello

e-mail: vincenzo.lippiello@unina.it

Co-supervisor:

e-mail:

PhD scholarship funding entity: PON Dottorati di ricerca su tematiche dell'innovazione e green - Azione IV.5 (Green)

General information

Francesca Pagano received in year 2021 the Master Science degree in Automation Engineering from the University of Napoli Federico II. She attended a curriculum in automation and robotics within the PhD program in Information Technology and Electrical Engineering. She received a grant from Ministero dell'Università e della Ricerca (MUR) with the PON program.

Study activities

Attended Courses

Year	Course Title	Type	Credits	Lecturer	Organization
1st	Probability calculus and elements of stochastic modelling	External course	4	Prof. Massimiliano Giorgio	Scuola Superiore Meridionale (SSM)
1st	Matrix Analysis for Signal Processing with MATLAB Examples	Ad hoc course	2	Prof. A. De Maio, A. Aubry, Dr. V. Carotenuto	ITEE
1st	Control of Complex Systems and Networks	MSc course	6	Prof. Pietro de Lellis	Polytechnic School
1st	Robotics Lab	MSc course	6	Prof. J. Cacace	Polytechnic School
1st	Operational Research: Mathematical Modelling, Methods and Software Tools for Optimization Problems	Ad hoc course	4	Prof. Adriano Masone	ITEE
1st	Theory and Applications of Contracting Dynamical Systems	External course	2.5	Prof. F. Bullo	Scuola Superiore Meridionale (SSM)
2nd	Model Predictive Course Control	External Course	4.0	Prof. A. Bemporad	Scuola IMT Alti Studi Lucca
2nd	Ethics and AI	External Course	2.4	Prof. G. Boella et al.	SipEIA
2nd/3rd	Strategic Orientation for STEM Research & Writing	Ad hoc course	5.0	Dr. Chie Shin Fraser	ITEE
3rd	Innovation and Entrepreneurship	Ad hoc course	4.0	Prof. Pierluigi Rippa	ITEE

Attended PhD Schools

Year	School title	Location	Credits	Dates	Organization
1st	IEEE RAS Summer School on Multi-Robot Systems 2022	Prague, Czech Republic	2.0	01-05/08/2022	Czech Technical University, Czech Republic
2nd	2023 Spring School on Course Transferable Skills	Napoli, Italy	2.0	24-25/05/2023	University of Naples Federico II, Italy

Attended Seminars

Year	Seminar Title	Credits	Lecturer	Lecturer affiliation	Organization
1st	Application of simultaneous block diagonalization of matrices	0.2	Prof. F. Sorrentino	University of New Mexico	ITEE
1st	IEEE Authorship and Open Access Symposium: Tips and Best Practises to Get Published from IEEE Editors	0.3	Rachel Berrington	Director, IEEE Client Services	IEEE Xplore
1st	Global and cluster synchronization in complex networks and beyond	0.2	Prof. Mattia Frasca	Univesità di Catania	SSM Dr. M. Coraggio
1st	An Introduction to Deep Learning for Natural Language Processing	0.2	Prof. F. Cutugno	Università degli Studi di Napoli Federico II	ITEE
1st	Explainable Natural Language Inference	0.2	Prof. F. Cutugno	Università degli Studi di Napoli Federico II	ITEE
1st	On using simple optimization techniques for tuning of UAVs	0.4	Prof. Dariusz Horla	Poznan University Technology	ITEE Prof. F. Ruggiero
1st	IEEE-ICRA 2022 workshop: Shared Autonomy in Physical Human-Robot Interaction: Adaptability and Trust	1.0	Multiple lecturers	Università degli Studi di Napoli Federico II	IEEE-ICRA M. Selvaggio et al.
1st	Introduction to Intellectual Property Managment	0.4	Antonia Maria Tulino	5G Academy	5G Academy
1st	IROS 2022 Workshop:	1.2	Prof. G.	University of	IROS

	"Human-Multi-Robot Systems: Challenges for Real World Applications"		Notomista et al.	Waterloo at al.	
2nd	Is control a solved problem for aerial robotics research?	0.2	Prof. Antonio Franchi	University of Twente	DIETI - UNINA Prof. F. Ruggiero
2nd	Multi-robot Control of Heterogeneous Herds	0.2	Prof. Eduardo Montijano	University of Zaragoza, Spain	SSM
2nd	From Romeo & Juliet Seminar to OceanOneK Deep-Sea Robotic Exploration	0.2	Prof. Oussama Khatib	Stanford University	DIETI – UNINA Prof. B. Siciliano
2nd	Exploring Advanced Aerial Robotics: A Journey into Cutting-Edge Projects and Neural Control	0.2	Eugenio Cuniato	ETHZ	DIETI – UNINA Julien Mellet
2nd	AI, Robots and Society: Challenges and Opportunities for Social Innovation	0.2	Dr. Amit Kumar Pandey	Company	DIETI - UNINA Prof. B. Siciliano
2nd	IEEE Authorship and Open Access Symposium: Tips and Best Practices to Get Published from IEEE Editors	0.3	Rachel Berrington	Director, IEEE Client Services	IEEE Xplore
2nd	Robotics Meets AI & 5G: The Future is Now!"	0.3	Prof. B. Siciliano	Università degli Studi di Napoli Federico II	IIT DELHI Neetish Patel
2nd	Comfort Intelligence for Human-Robot Interaction (HRI)	0.3	Dr. Sawabe Taishi	Interactive Media Design Laboratory – NAIST	INRIA Dr. Anatole Lecuyer
2nd	Designing Cooperative Multi-Agent Teams and Socially-Aware Autonomy	0.3	Prof. Alyssa Pierson	Boston University	ETHZ
2nd	Learning to optimize dynamic behaviors	0.3	Prof. Ludovic Righetti	New York University	INRIA
2nd	On Shapes, Robots, and Sensor-Based Controls	0.3	Prof. David Navarro	Hong Kong Polytechnic Universit	INRIA Dr. Alexandre Krupa
3rd	Workshop on Aerial Physical Interaction	1.0	Prof. Antonio Franchi et al.	Multiple affiliations	INRIA Dr. Marco Tognon
3rd	Agile flight of aerial robots under dynamical	0.2	Dr. Sihao Sun	Delft University of Technology	INRIA Dr. Marco Tognon

	uncertainties				
3rd	Aerial Cooperative Full Pose Manipulations Control in Air and in Contact with the Environment	0.2	Prof. Dario Sanalitro	University of Catania	INRIA Dr. Marco Tognon
3rd	Analytic center selection of optimization-based controllers for robot ecology	0.2	Prof. Gennaro Notomista	University of Waterloo	DIETI - UNINA Prof. Bruno Siciliano
3rd	Optimization-Based Planning and Control for Multi-Limbed Walking Robots	0.2	Dr. Dario Bellicoso	Boston Dynamics	DIETI - UNINA Prof. Bruno Siciliano
3rd	Generative AI for software engineering: strategies, impacts, and practical applications	1.0	A. Di Leva, C. Cuvi, G. Favale, A. Zoccoli		5G Academy
3rd	Introduction to Large Language Models: Evolution and the current state	0.4	Prof. Tanmoy Chakraborty	IIIT-Delhi	DIETI - UNINA Prof. Giancarlo Sperlì
3rd	Social Network Analysis: Methods and Applications	0.4	Prof. Tanmoy Chakraborty	IIIT-Delhi	DIETI - UNINA Prof. Giancarlo Sperlì
3rd	Biologically inspired Drones	0.2	Dr. Dario Floreano	EPFL	ICUAS
3rd	Aerospace City in Torino: Project and Strategy	0.2	Fulvia Quagliotti	Politecnico di Torino	ICUAS
3rd	Vision-based robotic perception: are we there yet?	0.2	Dr. Margarita Chli	ETH Zurich & University of Cyprus	ICUAS
3rd	Mapping Advanced Air Mobility to Mature Flight Operations	0.2	Dr. Chester Dolph	NASA	ICUAS
3rd	Marine Robotics Workshop	0.2	Multiple lecturers		I-RIM24 A. Ridolfi, D. Scaradozzi, G. Antonelli and G. Indiveri
3rd	Trends and challenges in collaborative robotics: perception, motion planning and control	0.2	Multiple lecturers		I-RIM24 L. Scalera, M. Terreran and E. Villagrossi
3rd	Profilo e Condizione occupazionale dei Dottori di Ricerca Rapporto 2024	0.5	Multiple lecturers		AlmaLaurea - Università degli Studi di Macerata
3rd	Miniaturisation of Optical	0.4	Tawfique	University of	DIETI - UNINA

	Spectrometers		Hasan	Cambridge	
3rd	QUIC: the secure protocol shaping the future of real-time communication over the Internet	0.4	Dr. Lorenzo Miniero	Meetecho	DIETI- Unina Prof. Simon Pietro Romano

Research activities

Francesca Pagano participated in the research on aerial robotics within PrismaLab research group. She focused on control approaches for agriculture-related applications, investigating the use of Nonlinear Model Predictive Control for a multi-robot persistent monitoring task. In the context of environmental monitoring, she also studied a distributed active sensing approach to estimate the parameters of a diffusive field with a team of drones.

She contributed to a research work focused on the execution and prioritization of a time-varying stack of tasks in redundant robotic systems. This work proposed a methodology leveraging Control Barrier Functions and constrained optimization and was experimentally validated on a Kuka manipulator.

Moreover, she contributed to developing and testing a control framework for the autonomous insertion of a bird diverter device on a power line cable with a quadrotor drone. Her work also included a customized version of the PX4 firmware, which was successfully deployed on multiple aerial platforms. Furthermore, she participated in the Leonardo Drone Contest, where she contributed to testing a multi-robot team consisting of a ground and an aerial robot.

Tutoring and supplementary teaching activities

- Tutorship activity for the course *Theory of Systems* (ING-INF/04), Prof. Fabio Ruggiero.
- Tutorship activity for the course *Foundation of Robotics* (ING-INF/04), Prof. Bruno Sciliano.
- Co-supervisior of 2 student M.Sc. Thesis (INGEGNERIA DELL'AUTOMAZIONE E ROBOTICA)

Credits summary

PhD Year	Courses	Seminars	Research	Tutoring / Supplementary Teaching
1st	26.5	4.1	29.4	0
2nd	8.4	3.0	44.9	1.6
3rd	9.0	6.6	45.5	1.6
Total	43.9	13.7	119.8	3.2

The course "Strategic Orientation for STEM Research & Writing" was followed during the second year, however, credits ware assinged in the third year. The 2 seminars credits missing in the second year have been gained in the third.

Research periods in institutions abroad and/or in companies

PhD Year	Institution / Company	Hosting tutor	Period	Activities
2st	INRIA, Rennes, France	Paolo Robuffo Giordano, CNRS Senior Scientist	01/09/2023-01/03/2024	Research on decentralized multi-robot field estimation and source seeking and on active sensing methods.
3st	INRIA, Rennes, France	Paolo Robuffo Giordano, CNRS Senior Scientist	10/06/2024-27/06/2024	Laboratory experiments with crazyflies drones.
3nd	Società Agricola Lenza Lunga	Giuliano Cacciapuoti	01/07/2024-31/12/2024	Evaluation of drones applications in agriculture. Study of UAV regulamentation.

PhD Thesis

In the PhD Thesis, Francesca Pagano addresses online optimization-based approaches for multi-robot monitoring tasks. In particular, she focuses on two distinct problems: the active estimation of a diffusive source and the persistent monitoring of some points of interest in a known area. In both cases, locally optimal control inputs must be computed to optimize a cost criterion while guaranteeing the respect of safety constraints. The proposed solutions utilize model-based approaches such as Nonlinear Model Predictive Control, Control Barrier Functions, and Gramian-based active sensing. The two novel frameworks' simulative and experimental results are presented and analysed. In addition, an approach for merging additional prioritized tasks is presented as a possible extension of the work.

Research products

Research results appear in 2 contributions to international conferences, *1* contribution to national conferences.

List of scientific publications

International journal papers

G. Notomista, M. Selvaggio, M. Santos, S. Maya, F. Pagano, V. Lippiello, C. Secchi
Beyond Jacobian-based Tasks: Extended Set-based Tasks for Multi-task Execution and Prioritization
Submitted to IEEE - Transaction of Robotics

F. Pagano, S. Marcellini, F. Ruggiero, M. Selvaggio, V. Lippiello
Multi-robot Nonlinear Model Predictive Control for Persistent Monitoring
To be Submitted

International conference papers

S. D'Angelo , F. Pagano, F. Ruggiero, V. Lippiello,
Development of a Control Framework to Autonomously Install Clip Bird Diverters on High-Voltage Lines,
International Conference on Unmanned Aircraft Systems (ICUAS),,
Warsaw, Poland, 2023, pp. 377-382, doi: 10.1109/ICUAS57906.2023.10156403.

S. D'Angelo, F. Pagano,F. Longobardi, F. Ruggiero, V. Lippiello,
Efficient Development of Model-Based Controllers in PX4 Firmware: A Template-Based Customization Approach
International Conference on Unmanned Aircraft Systems (ICUAS),,
Chania, Greece, 2024, 1155-1162, doi: 10.1109/ICUAS60882.2024.10556938.

National conference papers

J. Mellet, F. Pagano, F. Ruggiero, V. Lippiello,
Simplifying Quadrotor Frame Design: Toward Scalability with a Modular Robot,
IRIM-3D 2024: 6th Italian Conference on Robotics and Intelligent Machines,
Rome, Italy, Oct 25-27. 2024 – To appear in proceedings

Date 14/12/2024

PhD student signature _____

Supervisor signature _____