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

PhD Student: Vincenzo Scognamiglio

Cycle: XXXVII

Training and Research Activities Report

Academic year: 2021-22 – PhD Year: First

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Tutor: prof. Vincenzo Lippiello   _____

Co-Tutor: Eng. Alessandro Massa

Date: 28/10/2022

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Training and Research Activities Report

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Cycle: XXXVII
Author: Vincenzo Scognamiglio

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1. Information:

- **PhD student: Vincenzo Scognamiglio**
- **DR number: DR995995**
- **Date of birth: 30/11/1996**
- **Master Science degree: Automation Engineering**   **University: Federico II of Naples**
- **Doctoral Cycle: XXXVII**
- **Scholarship type: Leonardo S.p.A.**
- **Tutor: Prof. Vincenzo Lippiello**
- **Co-tutor: Eng. Alessandro Massa (Leonardo S.p.A.)**

2. Study and training activities:

Activity	Type[1]	Hours	Credits	Dates	Organizer	Certificate[2]
-Study on state of the art of the autonomous navigation in GPS denied environment - Study on state estimation algorithms - Study on SLAM algorithms - Revision of the paper Hybrid Visual SLAM for Underwater Vehicle Manipulator Systems	Research		10	From 01/11/2021 to 31/12/2021		
The learning landscape in deep neural networks and its exploitation by learning algorithm	Seminar	1	0,2	21/01/2022	Computational and Quantitative Biology Ph.D. Program	Y
- Study in deep of the RTAB-map algorithm - Starting implementation on Intel RealSense D435 - Study on a problem of actuator failure and consequent fault tolerant control	Research		9,8	From 01/01/2022 to 28/02/2022		

Global and Cluster Synchronization in Complex Networks and Beyond	**Seminar**	**1**	**0,2**	**10/03/2022**	**Modeling and Engineering Risk and Complexity PhD program - SSM**	**Y**
The search for Earth-like exoplanets in the Galaxy	**Seminar**	**1**	**0,2**	**24/03/2022**	**SSM – Cosmology, Space Science & Space Technology PhD Program**	**Y**
IEEE Autorship and Open Access Symposium: Tips and Best Practices to Get Published from IEEE Editors	**Seminar**	**1,5**	**0,3**	**30/03/2022**	**IEEE**	**Y**
Potential and challenges of next generation railway signaling systems: Moving Block and Virtual Coupling	**Seminar**	**1**	**0,2**	**06/04/2022**	**Prof. Valeria Vittorini – Consorzio Interuniversitario Nazionale Per L'Informatica (CINI)**	**Y**
On using simple optimization techniques for tuning of UAVs	**Seminar**	**2**	**0,4**	**27/04/2022**	**Dr. Fabio Ruggiero - DIETI - Unina**	**Y**
- Implementation of RTAB-Map Slam algorithm with RealSense D435 and Zed m - Test of the	**Research**		**8,7**	**From 01/03/2022 to 30/04/2022**		

Localization and Mapping tasks **- Testing RTAB-Map on a drone comparing results with ground truth** **- Simulation of Fault Detection Strategy for actuator faults**						
An informal discussion around stochastic control and free boundary problems	**Seminar**	**1**	**0,2**	**12/05/2022**	**PhD program in "Modeling and Engineering Risk and Complexity" – SSM**	**Y**
Vine Robots: Design, Challenges and Unique Opportunities	**Seminar**	**1**	**0,2**	**31/05/2022**	**Ph.D. Mario Selvaggio – DIETI - Unina**	**Y**
Workshop: Shared Autonomy in Physical Human-Robot Interaction: Adaptability and Trust	**Seminar**	**8**	**1,6**	**15/06/2022**	**Ph.D. Mario Selvaggio – ICRA 2022**	**Y**
Statistical data analysis for science and engineering research	**Courses**	**12**	**4**	**22-24-29-31/03/05-07/05/2022**	**Prof. Roberto Pietrantuono – ITEE Ph.D. Ad hoc courses**	**Y**
- Flight test in arena to test the SLAM algorithm and localization for Autonomous Flight **- Flight test in Leonardo Arena for the Leonardo Drone Contest**	**Research**		**4**	**From 01/05/2022 to 30/06/2022**		

- Implementation of a simulator for Vision Based Navigation **- Study of the state of the art for the problem of fault detection and identification of actuator in a flat quadrotor**						
Imprenditorialità Accademica	**Courses**	**9,5**	**4**	**26/05-13-14/06/2022**	**Prof. Pierluigi Rippa**	**Y**
IEEE RAS Summer School On Multi-Robot Systems 2022	**Doctoral School**	**50**	**2**	**01/08-05/08/2022**	**Czech Technical Univeristy in Prague**	**Y**
- Testing repetitive take-off and landing with UAV using RTAB-Map for indoor navigation **- Research for ROS compatible SLAM algorithms** **- On bench implementation of SLAM algorithms using Intel Realsense Cameras**	**Research**		**4**	**From 01/06/2022 to 31/08/2022**		
Neural Networks and Deep Learning	**Courses**	**39**	**6**	**20/10/2022**	**Prof-Giorgio Buttazzo – University Sant'Anna of Pisa**	**Y**
Operational Research: Mathematical Modelling, Methods and Software Tools for Optimization Problems	**Courses**	**10**	**4**	**14-21-28/09/5-12/10/2022**	**Prof. Adriano Masone – Dieti Department (Unina)**	**Y**

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

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2.1. Study and training activities - credits earned

	Courses	Seminars	Research	Tutorship	Total
Bimonth 1	0	0	10	0	10
Bimonth 2	0	0,2	9,8	0	10
Bimonth 3	0	1,3	8,7	0	10
Bimonth 4	4	2,0	4	0	10
Bimonth 5	6	0	4	0	10
Bimonth 6	10	0	0	0	11,5
Total	20	3,5	35	0	60
Expected	30 - 70	10 - 30	80 - 140	0 – 4.8	

3. Research activity:

To explore the broad topic of the autonomous navigation in GPS-denied environment, first step has been to study the state of the art of the problem. During this study, it has been recognized that the state estimation process plays a crucial role in the indoor autonomous navigation. Due to the absence of the GPS signal, the agent cannot know where it is. For this reason, we investigated many state estimation algorithms: Visual Odometry (VO), Visual Inertial Odometry (VIO), Lidar Odometry, Simultaneous Localization and Mapping (SLAM). Each of these algorithms can be distinguished by the sensor they use or the kind of output they give. SLAM algorithms have some advantageous features for indoor navigation, such as creation of a map and detecting loop closure. Since the SLAM problem has been studied for long, we started looking for the most robust algorithms already implemented. In general, these algorithms are tested on datasets or ground vehicle. Since the PhD activities are carried out within the aerial robotics group of the PRISMA Lab of the University of Naples Federico II, there is the opportunity to customise these algorithms for aerial application. The best sensor configuration has been investigated, focusing on cameras and depth sensors. Some SLAM algorithms (RTAB-Map, ORB-SLAM2) using the Intel Realsense family cameras have been tested. Then, we noticed that RTAB-Map had achieved the best performances; hence, we focused on implementing this algorithm on board an aerial robot. The possibility of fusing multiple camera outputs has been investigated to achieve high accuracy in the localization task. We tested the parameters and sensors configuration on a coaxial octocopter called "Leonardo" since it is involved in the "Leonardo Drone Contest". We had the opportunity to test the work in the contest's environment that replicates a city-like scenario where the drone must accomplish some tasks and the localization system has high priority since there is no other way to let the robot localizes itself. In this context, the Multi-Robot Summer School in Prague was an excellent opportunity to meet the aerial robotics group of the Czech Technical Univeristy, which is one of the most active in the field of autonomous exploration without GPS. During the last month of this first year, another family of cameras, the Zed from StereoLabs, has been considered. This sensor needs the presence of a GPU (graphics processing unit) and CUDA library. This could be the starting point for future research on this topic.

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During this year, we also had the opportunity to work on the Fault Detection and Isolation of an actuator in an aerial robot. We devised a data-driven estimator, and we are comparing this technique with others model-based. For this work, we started with a study of the state of the art of this problem to find the best method to compare with ours based on a neural network. We started implementing a simulation using Simulink.

4. Research products:

5. Conferences and seminars attended

6. Activity abroad:

7. Tutorship

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