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

PhD Student: Martina Guerritore

Cycle: XXXVI

Training and Research Activities Report

Year: First

Tutor: prof. Mauro D'Arco

Co-Tutors: Luigi Fratelli, Giuseppe Graber (Hitachi Rail STS)

Date: October 21, 2021

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PhD in Information Technology and Electrical Engineering

Cycle: XXXVI **Author: Martina Guerritore**

1. Information:

- **PhD student: Martina Guerritore**
- **DR number: DR995467**
- **Date of birth: 15/08/1995**
- **Master Science degree: Biomedical Engineering**
- **University: Federico II University of Naples**
- **Doctoral Cycle: XXXVI**
- **Scholarship type: *INPS - Dottorati INNOVATIVI – Intersettoriali, vertenti sulle tematiche dell'iniziativa "Industria 4.0"***
- **Tutor: prof. Mauro D'Arco**
- **Co-tutors: Ing. Luigi Fratelli Ph.D, Ing. Giuseppe Graber Ph.D (Hitachi Rail STS)**

2. Study and training activities:

Activity	Type[1]	Hours	Credits	Dates	Organizer	Certificate[2]
Robot Manipulation and Control	Seminar	2.5	0.5	17/11/2020	Prof. Bruno Siciliano	Y
Beyond Einstein Gravity: Dark Energy and Dark Matter as Curvature Effects	Seminar	1.5	0.3	19/11/2020 -	Prof. Salvatore Capozziello, SSM	Y
L'esperienza del progetto di tele-riabilitazione NEUROREAB	Seminar	1.5	0.3	24/11/2020	ing. D. Furno e ing. L. Romanelli	Y
The Ohta-Kawasaki model for diblock copolymers: stability and minimality of critical points	Seminar	1.5	0.3	26/11/2020	Prof. Nicola Fusco, SSM	Y
Telemedicina, e-health e «mobile health» si può davvero usare il digitale nel percorso assistenziale?	Seminar	1.5	0.3	26/11/2020	Dott.ssa Simonetta Scalvini	Y
Patent Searching Best Practices with IEEE Xplore	Seminar	1	0.2	27/11/2020	-Dr. Eszter Lukacs	Y
Network Systems, Kuramoto Oscillators, and Synchronous -	Seminar	1.5	0.3	03/12/2020	Prof. Francesco Bullo	Y
Quasar as high redshift standard candles	Seminar	1.5	0.3	10/12/2020	Guido Risaliti	Y
GDPR basics for computer scientists	Seminar	1.5	0.3	10/12/2020	Dr. Ringo Wenning	Y
Digital Project Management: Practices, processes, techniques, tools and scientific approach –	Seminar	2	0.4	18/11/2020	Prof. Dario Carotenuto	Y
"#andràtuttobene: Images, Texts, Emojis and Geodata in a Sentiment Analysis Pipeline"Seminar	Seminar	1.5	0.3	25/11/2020	Prof. Serena Pelosi	N
Learning and Probabilistic Modeling for Behavior Analytics	Seminar	1	0.2	09/12/2020 -	Prof. Giuseppe Manco	N
Data Driven Transformation in WINDTRE through Managers voice	Seminar	2	0.4	16/12/2020	Marcello Savarese, Chief Data Officer; Erica Bertone, Data Scientist; Amida Kudasheva, Data Engineer	N

"From Photometric Redshifts to Improved Weather Forecasts: an interdisciplinary view on machine learning" (ANTONIO PICARIELLO LECTURES ON DATA SCIENCE)	Seminar	1	0.2	13/01/2021	Dr. Kai Polsterer	N
Synchronization in Coupled Complex Systems	Seminar	1.5	0.3	14/01/2021	Dr. Jurgen Kurths	Y
"Cybercrime and e-evidence: the criminal justice response " (ANTONIO PICARIELLO LECTURES ON DATA SCIENCE)-	Seminar	2	0.4	20/01/2021-	Dr. Matteo Lucchetti	N
Probing the gravitational field, a fundamental viewpoint	Seminar	1.5	0.3	21/01/2021	Prof. Lorenzo Fatibene	Y
Advances in Machine Learning for Modelling and Understanding in Earth Sciences	Seminar	1.5	0.3	27/01/2021	Prof. Gustau Camps-Valls	Y
Quantum Simulators	Seminar	2	0.2	28/01/2021	Prof. Rosario Fazio	Y
Classification and precision therapy of glioblastoma	Seminar	1.5	0.3	29/01/2021-	Dr. Antonio Iavarone	Y
Finding Drivers in Cancer: from Primary Cancers to Resistance	Seminar	2	0.4	08/02/2021	Dr. Gad Getz	Y
“Machine learning: Causality lost in translation" (ANTONIO PICARIELLO LECTURES ON DATA SCIENCE)	Seminar	1.5	0.3	10/02/21	Prof. Edwin A. Valentijn	N
Approaches to Graph Machine Learning (ANTONIO PICARIELLO LECTURES ON DATA SCIENCE) –	Seminar	2	0.2	17/02/21	Dr. Miroslav Cepek	N
Variational approximations of the Griffith functional	Seminar	1	0.2	18/02/2021	Prof. Francesco Solombrino	Y
Signature reversion and other computational strategies for identifying drug repositioning opportunities -	Seminar	1.5	0.3	19/02/2021	Dr. Francesco Iorio	Y
Statistical data analysis for science and engineering research	Ad hoc Course, *(ITEE)*	-	4	From February 17, 2021 to March 4, 2021.	Prof. Roberto Pietrantuono	Y
Scientific Programming and Visualization with Python	Ad hoc Course, *(ITEE)*	-	2	From March 8, 2021 to March 10, 2021.	Prof. Alessio Botta	Y
"Visual Interaction and Communication in Data Science" (PICARIELLO LECTURES ON DATA SCIENCE)	Seminar	2	0.4	03/03/2021	Dott. Marco Quartulli	N
The coming revolution of Data driven Discovery (a fourth Methodological Paradigm of Science) (PICARIELLO LECTURES ON DATA SCIENCE, Lecture 17)	Seminar	1.5	0.3	25/03/2021	Prof. Giuseppe Longo	N
Elucidating and Targeting Mechanisms of Single Cell State Maintenance	Seminar	1.5	0.3	31/03/2021	Prof. Andrea Califano	Y
Why Do We Cooperate? Understanding and Modelling Societies using Reinforcement Learning	Seminar	1.5	0.3	01/04/2021	Prof. Mirco Musolesi	Y

Logic-based learning of Answer set programs	Seminar	1	0.2	08/04/2021	Prof. Mark Law (UniMi)	Y
Artificial Intelligence and 5G combined with holographic technology: a new perspective for remote health monitoring	Seminar	1.5	0.3	27/04/2021	Dr. Pietro Ferraro, Dr. Pasquale Memmolo	N
Fondamenti di Misure – Corso di laurea in Ingegneria Biomedica	Tutorship	3	0.12	13/04/21 (h1) 27/04/21 (h2)	Cattedra Prof. Mauro D'Arco.	-
Matrix Analysis for Signal Processing with MATLAB	Ad hoc Course, (ITEE)	-	2	20-21-27-28/04/2021	Proff. Augusto Aubry, Vincenzo Carotenuto, Antonio De Maio	Y
Machine Learning e Big Data per la salute	MSc course	-	9	II semester	Prof. Vincenzo Moscato	Y
Short and ultrashort, high voltage electric pulses for biological and medical applications-	Seminar	1.5	0.3	13/05/21	Dr.ssa S. Romeo	Y
L'avvincente Storia degli acceleratori	Seminar	1.5	0.3	14/05/21	Prof. V.G. Vaccaro	Y
Strategie terapeutiche innovative in campo immunologico: l'elettroporazioneper la veicolazione di molecole farmacologiche -	Seminar	1	0.2	20/05/21	*Dott.ssa Emanuela Signori*	N
"Ethics of quantification" - 19° PICARIELLO	Seminar	2	0.4	*26/05/21*	Dr.Andrea Saltelli	N
Dynamics of PDEs and recurrent motions	Seminar	1	0.2	*03/06/21*	*Prof. Pietro Baldi –*	Y
Introduzione alle applicazioni della RM in medicina	Seminar	1.5	0.3	*04/06/21*	*Prof. Arturo Brunetti*	N
End-to-end Optimization of augmented experience services over cloud integrated 5G Networks, 5G Academy	Seminar	2	0.4	16 June 2021	Dr. Jaime Llorca,	N
Statistic data analysis system for decision making, 20° PICARIELLO	Seminar	2	0.4	23/06/21	Dr Vincenzo Minei	N
Fondamenti di Misure – Corso di laurea in Ingegneria Biomedica	Tutorship	1	0.04	04/06/21	Cattedra Prof. Mauro D'Arco.	-
What is matter to particle physics and why try to observe its creation in lab	Seminar	1.5	0.3	15/07/2021	Prof. Vissani	Y
5G: Esposizione ai Campi Elettromagnetici e Metodologie di Misura	Seminar	4	0.8	16/07/21	Dott.ssa Sara Adda, Dott. Daniele Franci, Ing. Settimio Pavoncello	Y
TECNICHE DI ELABORAZIONE DEI SEGNALI PER LA BIOINGEGNERIA	MSc course	-	3	II semester	Proff. Vincenzo Carotenuto, Antonio De Maio	Y
PhD Excellence School "I. Gorini" 2021	Doctoral School	-	3	06-10/09/2021	-	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	**0**	**4.1**	**6.5**	**0**	**10.6**
Bimonth 2	**0**	**3.4**	**6.5**	**0**	**9.9**
Bimonth 3	**6**	**1.8**	**6.5**	**0.12**	**14.42**
Bimonth 4	**11**	**2.5**	**6**	**0.04**	**19.54**
Bimonth 5	**0**	**1.1**	**6.5**	**0**	**7.6**
Bimonth 6	**3**	**3***	**3**	**0**	**18.5**
Total	**20**	**12.9+3***	**35**	**0.16**	**71.06**
Expected	**30 - 70**	**10 - 30**	**80 - 140**	**0– 4.8**	

* Doctoral School : PhD Excellence School "I. Gorini" 2021

3. Research activity:

Research on assisted driving in railway scenarios is receiving significant attention. Moving objects recognition and tracking, as one of the most critical issues for assisted driving. Recognition and tracking of moving objects are two basic tasks of a collision-avoidance system in assisted driving.

In recent years, the Light Detection and Ranging (LiDAR) sensor has attracted more attention in object recognition and tracking due to its high performance in providing 3D representations of the urban scene in point clouds.

LIDAR is a technology, based on the transmission and reception of an impulse and giving back a points cloud with distance measurements of objects in the surrounding environment. LiDAR uses ultraviolet, visible, or near-infrared light to image objects. The distance d to a given object from the LiDAR is given by:

$$d = \frac{c * \Delta t}{2}$$

where c is the speed of light and Δt is the time taking the impulse from its emission to its reception.

A generic LiDAR has several channels (16-32-64-128) characterized by laser beams end detectors placed in a column configuration. The column configuration scans the surrounding environment by rotating to output 3D point cloud map with a 360 degree horizontal and 45 degree (for a LiDAR 128 channels) vertical field of view. Each lidar point includes Cartesian coordinates, distance to the sensor, intensity, laser ID.

The focus of my Ph.D. program includes the following steps: background filtering, object classification, and tracking of movements.

Furthermore with researchers of the Hitachi rails group, we acquired the data of urban lines in Naples with a LiDAR onboard the train.

My study focuses on deepening the Lidar system, its functions, and the reference literature during the first year. In particular, I focused on studying techniques for background filtering and selecting the Region of

Interest (ROI). As the first step, the ROI process was developed to filter areas that can not offer any information about moving objects. For example, points characterized by elevated vertical angles or the point behind LiDAR on the train's board will not draw moving objects in urban scenes. In this way, we have achieved a points reduction and speeded up processing. The second step focused on developing techniques for background subtraction (i.e., static object) that can be implemented in real-time and adaptable to any urban scene. The point cloud is reduced to only points representing moving objects. Algorithms have already been developed in the literature, but they are not real-time algorithms [1-2]. The most performing requires the aggregation of about 3000 frames to process correctly, i.e., about 2 minutes of acquisition. The algorithm uses the aggregation of about 50 frames (about 2.5 seconds), and the rotation frequency of the LiDAR is 20 frames/s. However, the algorithm needs to be improved because it does not take into account the density of the points decreases with an increasing range from the LiDAR.

Moreover, in this first year, I focus on the deepening of the data fusion techniques [3-4] and the exploration of the application fields; Structural Health Monitoring [5-6], Human Gait Analysis[7-8], Robot localization[9], Vehicle localization [10], and in particular to the railway sector[11-12]. We proposed a new data fusion method based on the generalized sampling expansions (GSE) Theorem, formulated by Papoulis [13], to improve the accuracy of kinematic signals such as position, velocity, or acceleration. It was tested with a three-channel structure that combines the acceleration, speed, and position sensors' signals. The algorithm was validated through MatLab simulations and the performances were compared with the results of a different sensor fusion approach based on the average of redundant signals. However, the paper will be submitted in the next few days.

[1]. *Song, Y., Zhang, H., Liu, Y., Liu, J., Zhang, H., & Song, X. (2020). Background Filtering and Object Detection With a Stationary LiDAR Using a Layer-Based Method. IEEE Access, 8, 184426-184436.*
[2]. *Lv, B., Xu, H., Wu, J., Tian, Y., & Yuan, C. (2019). Raster-based background filtering for roadside LiDAR data. IEEE Access, 7, 76779-76788.*
[3]. Mitchell, Harvey B. Multi-sensor data fusion: an introduction. Springer Science & Business Media, 2007.
[4]. Sun, Shu-Li, and Zi-Li Deng. "Multi-sensor optimal information fusion Kalman filter." Automatica 40.6 (2004): 1017-1023
[5]. Breuer, Peter, Tadeusz Chmielewski, Piotr Górski, Eduard Konopka, and Lesław Tarczy ́nski. 2008. The stuttgart162tv tower—displacement of the top caused by the effects of sun and wind.Engineering Structures 30(10), 2771–2781.
[6]. Brownjohn, J, M Stringer, G Tan, YK Poh, L Ge, and TC Pan. 2005. Experience with rtkgps system for monitoring164wind and seismic effects on a tall building.Structural Health monitoring of Intelligent Infrastructure (SHMII-2),165Shenzhen, 265–275.
[7]. Sprager, Sebastijan and Matjaz B Juric. 2015. Inertial sensor-based gait recognition: A review.Sensors 15(9),18922089–22127.
[8]. Le Moing, Josselyn and Ingo Stengel. 2015. The smartphone as a gait recognition device impact of selected parameters on gait recognition. In2015 International Conference on Information Systems Security and Privacy173(ICISSP), pp. 322–328. IEEE.
[9]. Borenstein, Johann and Liqiang Feng. 1996. Measurement and correction of systematic odometry errors in160mobile robots.IEEE Transactions on robotics and automation 12(6), 869–880.
[10]. Wan, Guowei, Xiaolong Yang, Renlan Cai, Hao Li, Yao Zhou, Hao Wang, and Shiyu Song. 2018. Robust193and precise vehicle localization based on multi-sensor fusion in diverse city scenes. In2018 IEEE International194Conference on Robotics and Automation (ICRA), pp. 4670–4677. IEEE.
[11]. Mirabadi, Ahmad, Neil Mort, and Felix Schmid. 1996. Application of sensor fusion to railway systems. In1751996 IEEE/SICE/RSJ International Conference on Multisensor Fusion and Integration for Intelligent Systems (Cat. No.17696TH8242), pp. 185–192. IEEE.
[12]. Otegui, Jon, Alfonso Bahillo, Iban Lopetegi, and Luis Enrique Díez. 2018. Evaluation of experimental gnss and18410-dof mems imu measurements for train positioning.IEEE Transactions on Instrumentation and Measurement 68(1),185269–279.
[13]. *Papoulis, A. (1977). Generalized sampling expansion. IEEE transactions on circuits and systems, 24(11), 652-654.*

4. Research products:

- *Smart living technologies for gait analysis in ergonomics, sport, rehabilitation and clinical diagnostics,* Mauro D'Arco, Martina Guerritore and Annarita Tedesco. Accepted and withdrawn to IEEE conference. Submitted to MDPI.
- *Multi-sensor data fusion approach for kinematic quantities,* Mauro D'Arco and Martina Guerritore. It will be submitted to MDPI in the next few days.

5. Conferences and seminars attended

- *PhD Excellence School "I. Gorini" 2021, 06-10/09/2021, 3CFU.*
- *I attended the "5G Italy The global Meeting in Rome" international conference.*

6. Activity abroad:

none

7. Tutorship

Please see the table above.