UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

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

Activities and Publications Report

PhD Student: Martina Guerritore

Student DR number: DR995467

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

PhD program student's start date: 01/11/2020
PhD program student's end date: 31/01/2024

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PhD scholarship funding entity:
Istituto nazionale della previdenza sociale (INPS).

General information

Martina Guerritore received in year 2020 the Master Science degree in *Biomedical Engineering* from the University of Napoli Federico II. She attended a curriculum in *Electrical and Electronic Measurements* within the PhD program in Information Technology and Electrical Engineering. She received a grant from Istituto Nazionale della Previdenza Sociale (INPS).

Study activities

Attended Courses

Year	Course Title	Type	Credits	Lecturer	Organization
1st	Statistical data analysis for science and engineering research	Ad hoc course	4	Prof. Roberto Pietrantuono	ITEE
1st	Scientific Programming and Visualization with Python	Ad hoc course	2	Prof. Alessio Botta	ITEE
1st	Matrix Analysis for Signal Processing with MATLAB	Ad hoc course	2	Proff. Augusto Aubry, Vincenzo Carotenuto, Antonio De Maio	ITEE
1st	Machine Learning e Big Data per la salute	MSc course	9	Prof. Vincenzo Moscato	University of Napoli Federico II
1st	Tecniche di elaborazione dei segnali per la bioingegneria	MSc course	3	Proff. Vincenzo Carotenuto, Antonio De Maio	University of Napoli Federico II
2nd	Sensori per applicazioni biomediche	MSc course	9	Prof. Egidio De Benedetto	University of Napoli Federico II
3rd	VI Corso Vice Ispettori Tecnici - settore Telematica della Polizia di Stato	External course	…		Polizia Di Stato, Italia

Attended PhD Schools

Year	School title	Location	Credits	Dates	Organization
1st	PhD Excellence School "I. Gorini" 2021	Online	3	06-10/09/2021	Italian "Electrical and Electronic Measurement" (GMEE) and "Mechanical and Thermal Measurement" (GMMT) associations
1st	XR Spring School 2022 - eXtended Reality Spring School 2022	Online	5	02-07/05/2022	University of Napoli Federico II, Italy

2nd	PhD Excellence School "I. Gorini" 2022	Salerno, Italy	3	05-09/09/2022	University of Salerno, Italy

Attended Seminars

Year	Seminar Title	Credits	Lecturer	Lecturer affiliation	Organization
1st	Robot Manipulation and Control	0.5	Prof. Bruno Siciliano	University of Napoli Federico II	ITEE
1st	Beyond Einstein Gravity: Dark Energy and Dark Matter as Curvature Effects	0.3	Prof. Salvatore Capozziello		SSM
1st	L'esperienza del progetto di teleriabilitazione NEUROREAB	0.3	ing. D. Furno e ing. L. Romanelli		ITEE
1st	The Ohta-Kawasaki model for diblock copolymers: stability and minimality of critical points	0.3	Prof. Nicola Fusco,		SSM
1st	Telemedicina, e-health e «mobile health» si può davvero usare il digitale nel percorso assistenziale?	0.3	Dott.ssa Simonetta Scalvini		ITEE
1st	Patent Searching Best Practices with IEEE Xplore	0.2	-Dr. Eszter Lukacs	IEEE - Client Service Manager	ITEE
1st	Network Systems, Kuramoto Oscillators, and Synchronous -	0.3	Prof. Francesco Bullo		SSM
1st	Quasar as high redshift standard candles	0.3	Guido Risaliti		SSM
1st	GDPR basics for computer scientists	0.3	Dr. Ringo Wenning	University of Napoli Federico II	ITEE
1st	Digital Project Management: Practices, processes, techniques, tools and scientific approach –	0.4	Prof. Dario Carotenuto	University of Napoli Federico II	ITEE
1st	"#andratuttobene: Images, Texts, Emojis and Geodata in a Sentiment Analysis Pipeline"	0.3	Prof. Serena Pelosi		ITEE

1st	Learning and Probabilistic Modeling for Behavior Analytics	0.2	Prof. Giuseppe Manco		ITEE
1st	Data Driven Transformation in WINDTRE through Managers voice	0.4	Marcello Savarese; Erica Bertone; Amida Kudasheva		ITEE
1st	"From Photometric Redshifts to Improved Weathe Forecasts: an interdisciplinary view on machine learning"	0.2	Dr. Kai Polsterer		ITEE
1st	Synchronization in Coupled Complex Systems	0.2	Dr. Jurgen Kurths		ITEE
1st	"Cybercrime and e-evidence: the criminal justice response "	0.4	Dr. Matteo Lucchetti		ITEE
1st	Probing the gravitational field, a fundamental viewpoint	0.3	Prof. Lorenzo Fatibene		ITEE
1st	Advances in Machine Learning for Modelling and Understanding in Earth Sciences	0.3	Prof. Gustau Camps-Valls		ITEE
1st	Quantum Simulators	0.2	Prof. Rosario Fazio		ITEE
1st	Classification and precision therapy of glioblastoma	0.3	Dr. Antonio Iavarone		ITEE
1st	Finding Drivers in Cancer: from Primary Cancers to Resistance	0.4	Dr. Gad Getz		ITEE
1st	“Machine learning: Causality lost in translation"	0.3	Prof. Edwin A. Valentijn		ITEE
1st	Approaches to Graph Machine Learning	0.2	Dr. Miroslav Cepek		ITEE
1st	Variational approximations of the Griffith functional	0.2	Prof. Francesco Solombrino		ITEE
1st	Signature reversion and other	0.3	Dr. Francesco Iorio		ITEE

	computational strategies for identifying drug repositioning opportunities				
1st	"Visual Interaction and Communication in Data Science"	0.4	Dott. Marco Quartulli		ITEE
1st	The coming revolution of Data driven Discovery (a fourth Methodological Paradigm of Science)	0.3	Prof. Giuseppe Longo		ITEE
1st	Elucidating and Targeting Mechanisms of Single Cell State Maintenance	0.3	Prof. Andrea Califano		ITEE
1st	Why Do We Cooperate? Understanding and Modelling Societies using Reinforcement Learning	0.3	Prof. Mirco Musolesi		ITEE
1st	Logic-based learning of Answer set programs	0.2	Prof. Mark Law		UniMi
1st	Artificial Intelligence and 5G combined with holographic technology: a new perspective for remote health monitoring	0.3	Dr. Pietro Ferraro, Dr. Pasquale Memmolo		
1st	*L'avvincente Storia degli acceleratori*	0.3	Prof. V.G. Vaccaro	Istituto Nazionale di Fisica Nucleare	ITEE
1st	*Strategie terapeutiche innovative in campo immunologico: l'elettroporazioneper la veicolazione di molecole farmacologiche -*	0.2	*Dott.ssa Emanuela Signori*	Consiglio Nazionale delle Ricerche Istituto di Farmacologia Traslazionale (IFT)	ITEE
1st	*"Ethics of quantification" -* 19° PICARIELLO	0.4	Dr.Andrea Saltelli		ITEE
1st	*Dynamics of PDEs and recurrent motions*		*Prof. Pietro Baldi –*		ITEE

1st	*Introduzione alle applicazioni della RM in medicina*	0.3	*Prof. Arturo Brunetti*		ITEE
1st	*End-to-end Optimization of augmented experience services over cloud integrated 5G Networks,* 5G Academy	0.4	Dr. Jaime Llorca		ITEE
1st	*Statistic data analysis system for decision making,* 20° PICARIELLO	0.4	Dr Vincenzo Minei		ITEE
1st	What is matter to particle physics and why try to observe its creation in lab	0.3	Prof. Vissani		ITEE
1st	5G: Esposizione ai Campi Elettromagnetici e Metodologie di Misura	0.8	Dott.ssa Sara Adda, Dott. Daniele Franci, Ing. Settimio Pavoncello		ITEE
2nd	Connecting the dots: Investigating an APT campaign using Splunk	0.4	Dr. Antonio Forzieri		ITEE
2nd	Threat Hunting Essentials	0.4	Group-IB		ITEE
2nd	Designing Quantum Algorithms	0.3	Prof. Michele Amoretti		ITEE
2nd	All roads lead to WebRTC: an introduction to Janus	0.4	Dr. Lorenzo Miniero		ITEE
2nd	Computational analysis of cancer genomes (CQB)	0.3	Nùria Lòpez-Bigas		ITEE
2nd	RAILS MID-TERM WORKSHOP	0.8	(refer to the poster)		
2nd	Project Vāc: can a Text-to-Speech Engine Generate Human Sentiments?	0.2	Vijay K. Gurbani		ITEE
2nd	The search for Earth-like exoplanets in the Galaxy	0.3	Giovanni Covone		ITEE

2nd	From basic principles in Spintronics to some recent developments toward spinorbitronics	0.3	Vincent Cros		ITEE
2nd	Capillary surfaces and a model of nanowire growth	0.2	Massimiliano Morini		ITEE
2nd	Likelihood-weighted active learning with application to Bayesian optimization, uncertainty quantification, and decision making in high dimensions	0.2	Themistoklis Sapsis		ITEE
2nd	Observing the VHE gamma ray sky with Cherenkov Telescopes in the XXI century	0.3	Lucio Angelo Antonelli		ITEE
2nd	Bench to Bytes to Bedside: Converting genomic data into healthcare tools	0.2	Serena Nik-Zainal		ITEE
2nd	Computational single-cell biology: from one to many cells	0.2	Oliver Stegle		CQB
2nd	Cellular strategies to overcome stimuli that arrest proliferation	0.2			CQB
2nd	Towards a political philosophy of AI	0.4	Mark Coekelbergh		ITEE
2nd	An Introduction to Deep Learning for Natural Language Processing	0.2	Dr. Marco Valentino		ITEE
2nd	Potential and challenges of next generation railway signaling systems: Moving Block and Virtual Coupling"	0.2	Prof. Valeria Vittorini		ITEE
2nd	Discovery using Systems Biology approaches	0.2	Mukesh Bansal		ITEE
2nd	Accelerating target identification	0.3	Giusy Della Gatta		ITEE

	and drug discovery through the power of high scale human genetics				
2nd	A day in the life of a Chief Data Officer models	0.4	Roberto Maranca		ITEE
2nd	Probing and infusing biomedical knowledge for pre-trained language models	0.4	Dr. Zaiqiao Meng		ITEE
	An introduction to quantum machine learning for engineers - I & II session	0.8	A. Delugan, M. Fazzari, L. Mazza		ITEE
2nd	Augmented reality for remote use of measurement instrumentation	0.4	Prof. Annalisa Liccardo	University of Napoli Federico II	ITEE
2nd	QoE management in 5G networks	0.4	Luigi Atzori		ITEE
2nd	Risk-modeling Complex Engineering Systems	0.3	Enrico Zio		ITEE
2nd	Introduction to Intellectual Property Management	0.4	Alessandro Marroni		ITEE
2nd	FROM RESILIENCE ASSESSMENT TO DESIGN FOR RESILIENCE: WHAT IS MISSING?	0.3	Paolo Franchi		ITEE

Research activities

Martina Guerritore participated in the research on

Simultaneous Localization and Mapping, commonly known as SLAM, is a technology used in robotics and autonomous systems to enable a device to navigate an environment while simultaneously creating a map of that environment. The primary goal of SLAM is to allow a device to understand its position within an unknown or partially known environment, while also building a map of the surroundings in real-time. Localization involves determining the device's position (often represented as a 3D pose – position and orientation) within a given environment. This is often achieved by comparing the current LiDAR data with previous scans and updating the estimated pose using algorithms such as Extended Kalman Filters or Particle Filters. LiDAR is a remote sensing method that uses laser beams to measure distances, creating highly accurate and detailed 3D

representations of the environment. This is particularly crucial for applications such as autonomous vehicles, drones, and mobile robots.

Lidar object detection refers to the process of identifying and categorizing objects in the surrounding environment using LiDAR technology. Object detection algorithms process the point cloud data to identify and categorize objects within the sensor's range. These algorithms use various techniques, including machine learning and deep learning, to recognize patterns and features associated with different object classes. Object detection not only involves identifying the presence of objects but also classifying them into specific categories and estimating their position respect with sensor. This classification is crucial for understanding the type of objects present in the environment. In many applications, especially in autonomous vehicles, real-time processing is essential for timely decision-making. LiDAR object detection systems are designed to efficiently process large volumes of data in real time.

Tutoring and supplementary teaching activities

I. Fondamenti di Misure – Corso di Laurea in Ingegneria Biomedica, Cattedra Prof. Mauro D'Arco
II. Misure Elettriche ed Elettroniche – Corso di Laurea Magistrale in Ingegneria Biomedica, Cattedra Prof. Mauro D'Arco
III. MSc thesis tutorship – Fernando Nicolini
IV. BSc thesis tutorship – Barbara Vanacore

Credits summary

Ph.D. Year	Courses	Seminars	Research	Tutoring / Supplementary Teaching
1st	20	15.9	35	0.16
2nd	17	9.4	54	0.16
3rd	-	0	110	0

Research periods in institutions abroad and/or in companies

PhD Year	Institution / Company	Hosting tutor	Period	Activities

2nd	European R&D centre (ERD) of HITACHI EUROPE SAS, France.*	Ing. Massimiliano Lenardi, Laboratory director	24 October 2022 – 31 October 2022	Research on Simultaneous Localization and Mapping (SLAM) with Light Detection and Ranging (LiDAR) technology. SLAM addresses the challenge of enabling an autonomous system, such as a robot or a vehicle, to simultaneously navigate and construct a map of its environment in real time.
3nd	European R&D centre (ERD) of HITACHI EUROPE SAS, France.*	Ing. Massimiliano Lenardi, Laboratory director	1 November 2022 – 31 March 2023	Research on Simultaneous Localization and Mapping (SLAM) with Light Detection and Ranging (LiDAR) technology. SLAM addresses the challenge of enabling an autonomous system, such as a robot or a vehicle, to simultaneously navigate and construct a map of its environment in real time.

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PhD Thesis

In the PhD Thesis, Martina Guerritore concentrated on developing advanced assisted driving systems for the tramway industry. The primary research objectives are to identify, categorize, and localize objects in the surrounding environment with modern LiDAR technology and, then estimate the position of the tram relative to an unknown environment.

Regarding the first objective, the thesis presents a comprehensive methodology that encompasses a set of basic operations such as background subtraction, pose estimation, and fitting of the 3D bounding box for each identified object. These operations contribute to a detailed state analysis of each identified object with respect to the tram. The aim is to assess potential collision risks and alert the driver accordingly. To achieve this, an approach balancing fast computation and accuracy is proposed, recognizing the need to navigate challenges posed by the limitations of commercial hardware in processing data output from high-performance LiDAR. Specifically, the research tackles issues associated with the constraints of existing solutions, particularly their tendency to falter when confronted with a dense point cloud.

Regarding the second objective, the thesis introduces two approaches for estimating the pose - position, and orientation - of the tram. Generally, the tram's position is determined through the utilization of Global Positioning System (GPS) technology. This advanced system enables the precise calculation of the tram's geographical coordinates on Earth. By receiving signals from multiple satellites, the GPS module on the tram triangulates its position, providing accurate latitude, longitude, and sometimes altitude information. This real-time positioning data is instrumental in guiding and navigating the robot, allowing it to traverse its environment with spatial awareness.

However, tunnels, tall buildings, and urban environments with high-rises can lead to signal reflections and blockages, causing inaccuracies. For this reason, the sensor fusion approach is proposed to estimate the position of the tram. Sensor fusion, which involves combining data from multiple sensors to improve accuracy and reliability, is particularly advantageous for localization in various applications. Some advantages of using sensor fusion for localization are Improved accuracy and robustness to sensor Failures. Combining data from multiple sensors helps mitigate the limitations and errors associated with individual sensors. This leads to a more accurate estimation of the device or vehicle's position. Moreover, if one sensor fails or provides unreliable data, other sensors can compensate for the deficiency. This redundancy enhances system reliability and ensures continuous localization even in the presence of sensor malfunctions.

Instead, estimating orientation involves integrating the angular rate (gyroscope) measurements from an Inertial Measurement Unit (IMU) to obtain the orientation (attitude) of the sensor with respect to a reference frame. This process involves numerically integrating the gyroscope data to update the orientation. Gyroscopes are sensitive to bias and other errors, leading to drift in the orientation estimation over time. Integration over long periods can result in accumulated errors. Complementary filters or Kalman filters are commonly employed to fuse data from the accelerometers and gyroscopes and refine the orientation estimate. However, the measurements from accelerometers need of pre-processing step helping to correct gravity-related errors. To avoid the accelerometers, a method to fusion point clouds and measurements gyroscope is proposed. Finally, to evaluate the effectiveness of all proposed strategies, real data is employed as a real case study.

Research products

Research results appear in *2* papers published in international journals, *2* contributions to international conferences.

List of scientific publications

International journal papers

D'Arco, Mauro, and Martina Guerritore.
Multi-Sensor Data Fusion Approach for Kinematic Quantities.
Energies 15.8 (2022): 2916.

Mauro D'Arco, Fratelli Luigi, Graber Giuseppe, Martina Guerritore.
Detection and Tracking of Moving Objects using Roadside LiDAR Sensors
IEEE Instrumentation & Measurement Magazine.

International conference papers

M. D'Arco, M. Guerritore.

A new method to estimate the attitude of a LiDAR through IMU and point-cloud data analysis

Submitted to IEEE I2MTC – International Instrumentation and Measurement Technology Conference.

D'Arco, Mauro, Martina Guerritore, and Annarita Tedesco.

Application Scenarios for Gait Analysis with Wearable Sensors and Machine Learning.

International Conference on 25th IMEKO TC4 Symposium and 23nd International Workshop on ADC and DAC Modelling and Testing (IWADC). DOI: 10.21014/tc4-2022.37

Patents and/or spin offs

none

Awards and Prizes

Best Project - PhD Excellence School "I. Gorini" 2022

Date 21/01/2024

PhD student signature Martina Guerritore

Supervisor signature Mauro D'Arco