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

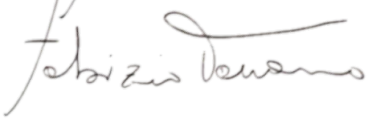
PhD Student: Fabrizio Tavano

Cycle: XXXV

Training and Research Activities Report

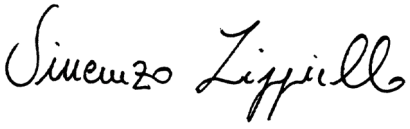
Year: First

student signature



Tutor: prof. Vincenzo Lippiello

tutor signature



Co-Tutor:

Date: October 21, 2020

1. Information:

- **PhD student: Fabrizio Tavano**
- **DR number: DR993890**
- **Date of birth: 29/08/1981**
- **Master Science degree: Electronic Engineer University: Second University of Naples**
- **Doctoral Cycle: XXXV**
- **Scholarship type: *no scholarship***
- **Tutor: Prof. Lippiello Vincenzo**
- **Co-tutor:**

2. Study and training activities:

Activity	Type[1]	Hours	Credits	Dates	Organizer	Certificate[2]
Title: Marked point processes for object detection and tracking in high resolution images: application to remote sensing data; lecturer: Prof. Josiane Zerubia; Organizer: Prof. Giuseppe Scarpa: date: 02/12/2019 credits: 0.4	Seminar	2	0.4	02/12/2019	Prof. Giuseppe Scarpa	yes
Workshop, title: Intelligenza Artificiale ed Etica; lecturers: Daniele Amoruso,Piero A. Bonatti, José M. Galvan, Riccardo Guidotti, Paola Inverardi, Roberto Prevete, Luciano Serafini, Viola Shiaffonati, date: 06/12/2019, credits: 1.6	workshop	8	1.6	06/12/2019	Università Federico II	yes
Title: Lo spazio cibernetico come dominio bellico; lecturer: Dott. Gian Piero Siroli;Organizer: Prof. Guglielmo Tamburrini; date: 15/11/2019, credits: 0.4	Seminar	2	0.4	15/11/2019	Prof. Guglielmo Tamburrini	yes
Robotic overhead line platform at support of the maintenance of trains and railway infrastructures: definition of the the requirements of a robot	Research		7	November-December 2019	Prof. Lippiello Vincenzo	yes

to facilitate maintenance activities and the monitoring of the conditions of railway infrastructures and fleet of trains; credits: 7						
Module title: Safety critical System for railway traffic management; Lecturer: Dr. Mario Barbareschi, phd of rete ferroviaria italialiana; date: 10/01/2020-27/01/2020; credits:3.3	Module		3.3	10/01/2020-27/01/2020;	Mario Barbareschi	yes
Title: Numerical methods for modelling, simulation and control for softrobots or robots in interaction with deformable environment; lecturer: Dr. Cristian Duriez-research Director INRIA; Organizer: Prof. Dr. Fanny Ficuciello: date: 14/01/2020 credits: 0.2	Seminar	1	0.2	14/01/2020	Prof. Dr. Fanny Ficuciello	yes
Title: Cybersecurity and Fuzzing for robots, blochchain, and more; lecturer: Dr.Antonio Ken Iannillo; Organizer:Dr. Roberta Natella; date:13/01/2020; credits:0.2	Seminar	1	0.2	13/01/2020	Dr. Roberta Natella	yes
Robotic overhead line platform at support of the maintenance of trains and railway infrastructures: Design of a concept by the 3D mechanical Cad Tool: Fusion 360, of Autodesk; credits: 10	Research		10	Jenuary-February 2020	Prof. Lippiello Vincenzo	yes
Title: “How to get published with the IEEE?”; lecturer: Dr.ssa Eszter Lukacs; Organizer:DIETI; date:20/04/2020; credits:0.4	Seminar	2	0.4	20/04/2020	DIETI	yes
Title: "Computational Biology: Large scale data analysis to understand the molecular bases of human diseases" lecturer: prof. Michele Ceccarelli; organizer: DIETI; date: 09/04/2020;credits:0.2	Seminar	1	0.2	09/04/2020	DIETI	yes

Title: "Elettromagnetismo e Salute" lecturer: prof.ssa Rita Massa; date: 09/04/2020; credits:0.2	Seminar	1	0.2	09/04/2020	Prof.Rita Massa	no
Study of a neural network to recognize the presence of defects inside the railway rail by the evaluation of measures conducted throw Magnetic Flux Leakage (MFL) inspection for non-destructive testing (NDT); credits: 10	Research		10	March 2020-October 2020	Prof. Lippiello Vincenzo	yes
Module: Robotic interaction control, Lecturer Prof. Siciliano: 6 credits	Module		6	Second semester	Prof. Siciliano Bruno	yes
Module: Robotic lab, Lecturer Prof. Lippiello: 6 credits	Module		6	Second semester	Prof. Lippiello Vincenzo	yes
Field and service robotics, Lecturer Prof. Ruggiero: 6 credits	Module		6	Second semester	Prof. Ruggiero Fabio	yes
Module: StartCupCampania 2020, Lecturer Prof. Rippa : 5 credits	Module		5	Second semester	Prof. Rippa	yes
Module: Intelligenza Artificiale, Lecturer Prof.ssa Amato Flora: 6 credits	Module		6	Second semester	Prof.ssa Amato Flora	yes
webinar, title: Virtual seminars on sensing with nano-devices; lecturers: 1.time: 2:40-3:40 Jerome Wenger, duration: 1h 2.time: 3:40-4:40 Carsten Rockstuhl: duration: 1h 3.time: 4:40-5:40 Leonetta	Webinar	4	0.8	20 may 2020	Plasmonica	yes

Baldassare: duration: 1h 4.time 5.40-6:40Monica Fleischer: duration: 1h Organizer: Plasmonica date: 20 may 2020, credits: 4 hours, credits: 0.8						
programma dei webinar di Innovation Village 2020, seminar: " La programmazione europea e la ricerca. Nuovi scenari della programmazione europea dopo il 2020. La gestione di un progetto di ricerca "; lecturer: Filippo Ammirati; Organizer: Università degli Studi di Napoli Federico II; date: 13 may 2020, 2 hours, credits: 0.4	webinar	2	0.4	13 may 2020	Università degli Studi di Napoli Federico II	yes
programma dei webinar di Innovation Village 2020, seminar: " Health 4.0 – La rapidità della medicina e la velocità del cambiamento del nostro mondo"; lecturer: Paolo Netti; Organizer: Università degli Studi di Napoli Federico II; date: 14 may 2020, 2 hours, credits: 0.4	webinar	2	0.4	14 may 2020	Università degli Studi di Napoli Federico II;	yes
programma dei webinar di Innovation Village 2020, seminar: "Realtà virtuale e salute reale. Healt 4.0: dal bit alla mente, spazi virtuali e salute" lecturer: Valentino Megale; Organizer: TecUp; date: 15 may 2020, 2 hours, credits:0.4	webinar	2	0.4	15 may 2020	TecUp	yes
webinar: "Large Scale	webinar	2	0.4	6 may	Prof. Carlo	yes

Training of Deep Neural Networks" lecturer: Dott.Giuseppe Fiameni; Organizer: Prof. Carlo Sansone; date: 6 may 2020, 2 hours, credits: 0.4				2020	Sansone	
seminar: Exploring Autonomy in Robotic Flexible Endoscopy, Lecturer Prof. Pietro Valdastri, Organizer: Prof.ssa Fanny Ficuciello, date: 12 june 2020 2 hours, credits: 0.4	Seminar	2	0.4	12 june 2020	Prof.ssa Fanny Ficuciello	yes
seminar: Noninvasive Mapping of Electrical Properties using MRI, lecturer: Prof. RICCARDO LATTANZI, Organizer: Prof. Rita Massa, Prof.Giuseppe Ruello, date: 11 june 2020; duration 2 hours, credits: 0.4	seminar	2	0.4			yes
Study of a neural network to recognize the presence of defects inside the railway rail by the evaluation of measures conducted throw Magnetic Flux Leakage (MFL) inspection for non-destructive testing (NDT); Comparison between a Convolutional neural network and and a long short-term memory network; comparison between a Convnet with input generated by combination of measures captured by multiple sensors, and a Convnet where every single input depends by measures of a single sensor; credits 10	research		10	May-August 2020	Prof. Lippiello Vincenzo	yes
Title: Machine learning ;	Module		3.6		From 6 july	yes

lecturer: Marco Aiello, Anna Corazza, Diego Gragnaniello, Francesco Isgrò, Roberto Prevete, Francesco Raimondi, Carlo Sansone; organizer: DIETI, Università di Napoli Federico II, Istituto di ricerca IRCCS SDN, Napoli, Dipartimento di Scienze mediche traslazionali, Università di Napoli Federico II; credits: 3.6 Date Hours July 6 2020 11.00-13.00 July 7 2020 11.00-13.00 July 8 2020 11.00-13.00 July 9 2020 11.00-13.00 July 10 2020 11.00-13.00 July 13 2020 11.00-13.00 July 14 2020 11.00-13.00 July 15 2020 11.00-13.00 July 16 2020 11.00-13.00 July 17 2020 11.00-					2020 to 17 july 2020	
Title: How do Emerging Technologies like Cobots, RFID, Augmented Reality & Digital Twin drive the Digitalization Paradigm under Industry 4.0; lecturer: Dr. Wasim Raad; Organizer: The professorship Measurement and Sensor Technology (MST) at TU-Chemnitz (Germany), organized within the activities of the DAAD project PraSEE, date: 5th of August 2020 credits: 0.2	seminar	1	02	5th of August 2020	The professorship Measurement and Sensor Technology (MST) at TU-Chemnitz (Germany), organized within the activities of the DAAD project PraSEE	yes
Workshop, title: "Wearable Brain-Computer Interface for Augmented Reality-based Robotic Applications in Industry 4.0";organizer The professorship Measurement and Sensor Technology (MST) at TU-Chemnitz (Germany),	Workshop	1	0.2	29th of July 2020	The professorship Measurement and Sensor Technology (MST) at TU-Chemnitz (Germany),	yes

organized within the activities of the DAAD project PraSEE lecturers: Prof. Pasquale Arpaia date: 29th of July 2020 credits: 0.2					organized within the activities of the DAAD project PraSEE	
Title: "La Digital Transformation in Sanità per fronteggiare l'emergenza Covid"; Organizer: INNOVATION VILLAGE 2020; date: 09/07/2020, credits: 0.2, lecturers: 1.introduzione e moderatrice: Annarita Falanga, Direzione Villa delle Ginestre 1.La realtà virtuale in riabilitazione: Lucio Tommaso De Paolis, Direttore dell'AVR Lab del Dipartimento di Ingegneria dell'Innovazione dell'Università del Salento 1.Gamification in Sanità e presentazione di IamHero srl, start up innovativa che cura i bambini affetti da ADHD con i giochi digitali 1.Pierpaolo Di Bitonto, Head of Research & Development Grifo multimedia Brain Computer interface come tecnologia per l'autismo e per le disabilità motorie 1.Pasquale Arpaia,Direttore ARHeMLab of DIETI Excellence Department, Dipartimento di Ingegneria elettrica e delle Tecnologie dell'Informazione – Università degli Studi di Napoli Federico II	Seminar	1	0.2	09/07/2020	INNOVATION VILLAGE 2020; Universittà di Napoli Federico II	yes

seminar: AI Webinar Series on Deep Learning for CINI AIIS Labs, lecturer: 1.Multi-GPU Training using Horovod (20' + 20' q/a) - Gunter Roeth 2.Deploying Models with TensorRT (20' + 20' q/a) - Niki Loppi 3.Profiling with NVTX (20' + 20' q/a) - Giuseppe Fiameni Organizer: NVIDIA, CINI National Lab, CINECA, date:02 july 2020 2 hours, credits: 0.4	Seminar	2	0.4	02 july 2020	NVIDIA, CINI National Lab, CINECA	yes yes
Study of a neural network to recognize the presence of defects inside the railway rail by the evaluation of measures conducted throw Magnetic Flux Leakage (MFL) inspection for non-destructive testing (NDT); Development and Testing of a Fuzzy logic based approach applied on the output of the Convolutional neural network, in order to decide if there is a case of failure or not, in the railway rail under analisys. Credits: 10	Research		10	July-October 2020	Prof. Lippiello Vincenzo	yes
ITCH-ITEE PhD module: Strategic Orientation for STEM Research and Writing, lecturer: Prof. Frazer	Module		3.6	Second semester	Prof. C. Fraser	yes
Seminario Web "Algorithmic Accountability - Affidabilità e responsabilità degli algoritmi"; date: 24 settembre 2020 ore 17.00; Organizer: Fondazione Ugo Bordoni;Lecturer: ", il professor Joshua Kroll, Fabio Bassan, Giuseppe Francesco Italiano, Stefano Quintarelli,	Seminario	2	0.4	24 settembre 2020	Fondazione Ugo Bordoni	no

Marco Bianchi						
Workshop: La mappatura internazionale delle start-up dei droni Organizer: Osservatorio Droni, Politecnico di Milano, Osservatori.net digital innovation	Workshop	3	0.6	30 settembre 2020	Osservatorio Droni, Politecnico di Milano, Osservatori.net digital innovation	yes
Title DOTTORATO E IMPRESE: TALENTI, RICERCA E INNOVAZIONE del 26 Ottobre 2020 organizer: università di Bologna	Seminar	2	0.4	26 Ottobre 2020	Università di Bologna	yes
Mathematics of the Finite Element Method- PhD Course	Module		5	Second semester	Prof. Calabrò	yes
Seminario: "Salute, algoritmi e Intelligenza Artificiale. Tecnologie digitali al servizio di medici e pazienti"	Seminar	2	0.4	22 ottobre 2020	Fondazione Ugo Bordoni	no
Valutazione dei livelli di esposizione e del rispetto dei limiti delle antenne e 5G; Lecturer:Prof. MD Migliore Misure di segnali complessi nell'ambiente: Sistemi 5G; Lecturer: Dr D. Franci Estrapolazioni su segnali 4G, 5G, Lecturer: Dr.S. Adda; Organizer: Prof. Rita Massa, Prof. Giuseppe Ruello	Seminar	5	1	20/10/2020	Prof. Rita Massa, Prof. Giuseppe Ruello	yes
study of a specific allocation and patrolling task algorithm to optimize the coordination and strategic movement of the robot team for an effective and fast fulfillment of the common target, to sanitize and keep the environment, sanitized over the day. The centralized strategy of cooperation will be chosen and optimized thanks to Model predictive control methods and Q-learning	Research		10	September-October 2020	Prof. Lippiello Vincenzo	yes

methods. Comparison between the results obtained by the adoption of model-based or model-free methods.						

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	2.4	7	0	9.4
Bimonth 2	3.3	0.4	10	0	13.7
Bimonth 3	0	0.8	10	0	10.8
Bimonth 4	29	3.6	10	0	42.6
Bimonth 5	3.6	1	10	0	14.6
Bimonth 6	8.6	2.8	10	0	21.4
Total	44.5	11	57	0	112.5
Expected	30 - 70	10 - 30	80 - 140	0 – 4.8	

3. Research activity:

During my first year I have taken part of two topics of research:

Topic 1: Development of Convolutional Neural Network and fingerprinting system for automated railway damage detection using Magnetic flux leakage technology

The general vision about robotics is an opportunity to reduce costs of maintenance, security and safety by a low-cost technology that works with autonomy, where every mission, that the robot does, is traced and submitted to a database system responsible of the holding of every evidence.
we have done a study of a technology based on magneto-inductive principle for the constant monitoring of the railway infrastructure. A robot may adopt the technology developed in this work for the inspection of the railway in autonomy, in a h24 service. The magneto-inductive principle is innovative because it permits to reduce costs of maintenance and it is easier to implement on board of a robot. The actual methodology of inspection of anomalies uses acoustic waves thanks to piezoelectric technology. To transmit the vibrations inside of the metal of the railway it is necessary to distribute on the surface of the rail a liquid for the adaptation of the vibration impedance. This necessity implies the installation of tanks on board of robots. The magneto-inductive method does not need of adaptation medium but it is only necessary to install on board of a robot natural magnets for magnetization of the rail. In our work, we show first results of a study about the use of Magnetic flux leakage (MFL) technique to control the quality of a rail, using a

machine learning approach thanks to the use of a convolutional neural network configured to realize novelty detection.
We are working on a study about the possibility of use of Magnetic flux leakage (MFL) in the railway sector for Non Destructive Testing, to find defects not in the rope as usual, but in the rail. It is the first time that this technique is experimented in this kind of application.
For this scope, we have used an embedded rail, characterized by a known number of defects, that is installed in San Donato test circuit sited in Bologna (Italy), a plant realized for testing of innovative technology solution by the society Rete Ferroviaria Italiana S.p.A., the Italian infrastructure manager society.
To analyze the data it is applied for the first time for MFL technique to implement non-destructive testing, a convolutional neural network trained for novelty detection.
The neural network is trained to recognize the segments of rail without defects, and to signalize the anomaly in phase of testing if it is present.
To detect the very little and more deep in the metal anomalies, that are present in some point of the embedded rail under test, it is used for the first time a fingerprint technique to determine the differences between what the convnet has seen as normal, and what it has classified as anomaly. The fingerprint technique that is proposed in the present paper, is innovative because it is applied to the outputs of the neural network, and also because it admits the possibility to assign at the same fingerprint more than one kind of defect. Every fingerprint, in fact, is built to be associated also to defects of the same nature but different in dimensions or more distant from the site of application of the magnetic sensor.

Topic 2: Development of an efficient strategy to lead a team of robot working for the sanification of the railway stations

The role of railway stations in large cities is evolving: the number of services they offer is growing more and more. The stations are no longer simple nodes of the railway network, for the access to the trains as passengers, facilitating the intermodal road-rail exchange. The stations are now location of many other services, they have shops and catering activities, places for recreation and aggregation, environments suitable to organize public events. They are therefore strategic elements for the life of modern cities, which are increasingly popular.
Modern society is increasingly open and connected, and the demand for transport is ever increasing. In this context, the railway sector is essential to respond to the new mobility needs.
On the other hand, the probability of spreading diseases due to the presence of microorganisms (bacteria and viruses) between places of great population density, apparently distant between them, but indeed very connected by modern transport systems, is increasing more and more.
In recent years we have seen the spread of diseases from distant cities, such as Sars, Spanish flu, avian flu, and last and perhaps most important for the impact it has recently had on our lives, the Covid-19.
The Italian state railways must therefore participate in the front line in the fight to reduce the infection from Covid19.
Furthermore, it is fundamental and strategic that the Railway Transport Company and the Infrastructure Manager Company as Rete Ferroviaria Italiana, are equipped with adequate and modern tools to prevent future diseases from finding opportunities in the stations and on board of trains to spread and reach cities, even distant cities, destinations of the public transport service.

This study proposes the use of a group of robot-sanitizers for use in current railway stations.
We start with the hypothesis that the these robots will be equipped with electric motors that allow movement on the wheels, they will work with autonomy,
During the present study, it will be developed a specific allocation and patrolling task algorithm to optimize the coordination and strategic movement of the robot team for an effective and fast fulfilment of the common target, to sanitize and keep the environment, sanitized over the day.
In particular, we suppose that a server system will be able to recognize the aggregations of passengers thanks to the localization of the position of smartphones thanks to the trilateration technique applied to WiFi signal between more than one access point in the station.
The team of robots will be driven in an appropriate manner to sanitize the environment in continuous manner during the day. The robots will be able to cooperate, choosing effective paths, distinguishing obstacles from people, and applying different disinfection methods, such as the diffusion of bactericidal chemicals, or lighting up the surfaces by UV rays.
The centralized strategy of cooperation will be chosen and optimized thanks to Model predictive control methods and Q-learning methods. In this manner, it will be possible to do a comparison between the results obtained by the adoption of model-based methods than model-free reinforcement learning algorithm methods.

4. Research products:

in Preparation:
Authors: Fabrizio Tavano & Alessandro Paolo Daga, Luigi Garibaldi, Aldo Canova, Alessandro Fasana, Vincenzo Lippiello, Bruno Siciliano, Riccardo Caccavale, Eugenio Fedeli, Vincenzo Calà, Mirko Ermini, Marcella Di Mario, Francesco Giuliano, Franco Stivali, Riccardo Santoro, Fiorella Fedele, (2020).
Title: Development of Convolutional Neural Network and fingerprinting system for automated railway damage detection using Magnetic flux leakage technology.
In process of submission to the journal: IET Electrical Systems in Transportation-.

5. Conferences and seminars attended

none

6. Activity abroad:

none

7. Tutorship

none