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

PhD Student: Nicola Albarella

Cycle: XXXV

Training and Research Activities Report

Year: First

Nicola Albarella

Tutor: prof. Stefania Santini

Stefania Santini

Date: October 21, 2020

Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle: **Author:**

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1. Information:

- ➢ **PhD student: Nicola Albarella**
- ➢ **DR number: DR993892**
- ➢ **Date of birth: 20/07/1993**
- ➢ **Master Science degree: Automation Engineering   University: Federico II**
- ➢ **Doctoral Cycle: XXXV**
- ➢ **Scholarship type: funded by Kineton s.r.l.**
- ➢ **Tutor: Prof. Stefania Santini**
- ➢ **Co-tutor: -**

2. Study and training activities:

Activity	Type[1]	Hours	Credits	Dates	Organizer	Certificate[2]
Intelligenza Artificiale ed Etica: La ricerca in IA alla prova delle sfide etiche	Ad hoc course	8	1.6	06/15/2019	DIETI	N
Deep learning onramp	Seminar	2	0.4	21/11/2019	Prof. Carlo Sansone	Y
Lo spazio cibernetico come dominio bellico	Seminar	2	0.4	15/11/2019	Prof. Guglielmo Tamburrini	Y
Safety Critical Systems for Railway Traffic Management	Ad hoc courses	20	3.3	10/01-17/01/2020	DIETI	Y
Computational Biology: Large scale data analysis to understand the molecular bases of human diseases	Seminar	1	0.2	09/04/2020	DIETI	Y
Elettromagnetismo e salute	Seminar	1	0.2	09/04/2020	DIETI	N
How to get published with the IEEE?	Seminar	2	0.4	20/04/2020	Dr. Alessandra Scippa	Y
Innovation management, entrepreneurship and intellectual property	Ad hoc course	18	5	05/05-05/06/2020	Prof. Pierluigi Rippa	Y
Scuola Nazionale Dottorandi di Elettronica Ferdinando Gasparini	Doctoral School	30	9	14/10-18/10/2019	Raffaele Martone	Y
Large Scale training of Deep neural Networks	Seminar	2	0.4	06/05/2020	DIETI	Y

La programmazione europea e la ricerca. Nuovi scenari della programmazione europea dopo il 2020 – La gestione di un progetto di ricerca	Seminar	2	0.4	13/05/2020	Innovation Village 2020	N
SAS Analytics	Seminar	2	0.4	14/05/2020	SAS Academinc Program Manager	N
Planning 5G under EMF constraints: challenges and opportunities	Seminar	2	0.4	18/05/2020	Prof. Luca Chiaraviglio	N
Exploring Autonomy in robotic Flexible Endoscopy	Seminar	2	0.4	12/05/2020	Prof. Fanny Ficuciello	Y
Machine Learning	Ad hoc course	12	2.4	06/07-17/07/2020	ITEE - ICTH	Y
Metodi Formali	M.Sc. Course	18	3		Prof. Valeria Vittorini	Y
Big Data Analytics and Business Intelligence	M.Sc. Course	38	6		Prof. Antonio Picariello/ Prof. Vincenzo Moscato	Y
Sistemi Embedded	M.Sc. Course	38	6		Prof. Antonino Mazzeo	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	1.6	0.8	7.6	0	10
Bimonth 2	3.3	0	6.7	0	10
Bimonth 3	0	0.8	9.2	0	10
Bimonth 4	14	2	0	0	16
Bimonth 5	11.4	0	2.6	0	14
Bimonth 6	6	0	0	0	6
Total	36.3	3.6	26.1	0	66
Expected	30 - 70	10 - 30	80 - 140	0 – 4.8	

3. Research activity:

- ***Background study of ADAS and Autonomous Vehicle (AV) state of the art and state of the research.*** The first few months of the first year have been dedicated to the study of the state of the art of ADAS applications. Particular attention has been given to the different control architecture solutions that can be found both in the research literature and in the automotive industry. The identification of the main components of these architectures has been carried out, namely sensor processing, mapping and motion planning, control. Moreover, the main ADAS components have been identified (e.g. Adaptive cruise control, Lane Centering, Collision Avoidance) which are the building blocks of a possible AV architectural solution. The differences between an Autonomous Vehicle and an assisted vehicle (through ADAS) has been highlighted with respect to the SAE standard, i.e. the six levels of autonomy. The background study lead to the definition of open problems and possible future roadmaps.
  In parallel to the previous study, state of the art development and testing techniques have been investigated, with particular attention given to the Model Based Design approach, the V-cycle model and all the software related standards which are of interest of the automotive industry (e.g. ISO 26262, MISRA C, AUTOSAR etc.)

- ***Research on the vehicle nonlinear dynamics with attention to road-tire interactions and their influence on ADAS applications.*** To this day automotive manufacturers design and test the ADAS functionalities in well-structured and defined environments, typically implying the adoption of a flat and dry road. However, the main component for performance degradation in terms of safety, is the road asphalt condition, which is rarely taken into account in the literature. The presence of rain, snow or ice on the road leads to increasing stopping distances, thus motion and behaviour planning logics must be suitably adapted. These considerations lead to the extensive study on the nonlinear tire dynamics in longitudinal and lateral directions. A co-simulation platform has been defined, using Matlab/SUMO, able to simulate highly detailed vehicle and tire dynamics, traffic and variable road conditions. Three ADAS functionalities have been designed, namely Adaptive Cruise Control, Autonomous Emergency Brake, Anti-Lock Braking System, taking into account tire-road grip coefficients, reaching enhanced safety performance with respect to stopping distance. These three ADAS functionalities are responsible for longitudinal chassis control of an assisted or fully automated vehicle. The proposed control architecture comprises a road condition estimation module which can be executed in real time, on the basis of the signal available on the vehicle network. More information about this subject can be found in the first research product.

- ***Development and testing of a Forward Collision Warning (FCW) ADAS application based on radar, camera and fusion of both sensors.*** The forward collision warning(FCW) is a vehicle safety system designed to prevent or reduce the severity of a collision with other road users. FCW-systems warn the driver so that he is able to perceive the hazard and to prevent any accident. The severity of the warning depends on how much time is left for the driver to avoid the accident. FCW could be implemented using several sensors and technologies. This research activity in related to the implementation of the system based on radar only, camera only and the

combination of both in order to evaluate the pros and cons of each configuration, in term of performances, robustness and cost. The three versions have been implemented following the Model Based Design approach and evaluated through simulation at first, and later in a real vehicle (VIL). Results showed enhanced measurements robustness of the radar-based FCW with respect to the camera-based. Moreover, the camera solution presents higher implementation difficulties, being the detection of road users based on Deep Neural Network architectures. Nonetheless the camera is richer in information with respect to radar (e.g. texture, colour etc.) enabling the development of more ADAS functionalities (Lane detection, Traffic signs detection etc.). The last solution is based on the fusion of both sensor, combining the pros of both architectures at a higher cost.

4. Research products:

- N. Albarella, S, Santini, V. M. Arricale, R. Brancati, A. Sakhnevtch, On-board road friction estimation technique for autonomous driving vehicle following maneuvers, Mechanical Systems and Signal Processing (submitted)

5. Conferences and seminars attended

6. Activity abroad:

7. Tutorship