PhD in Information Technology and Electrical Engineering

Università degli Studi di Napoli Federico II

PhD Student: Angelo Coppola

XXXIV Cycle

Training and Research Activities Report – First Year

Tutor: Stefania Santini

1. Information

    a. Angelo Coppola, MS degree in Hydraulic and Transportation Systems Engineering – University of Naples Federico II.

    b. XXXIV Cycle- ITEE – Università di Napoli Federico II.

    c. Fellowship type: "Borsa POR".

    d. Tutor: Prof.ssa Stefania Santini.

    e. Co-Tutor: Luisa Andreone and Anita Fiorentino, FCA group

2. Study and Training activities

    a. Courses

        - "How to publish a scientific paper" (0.4 CFU),
          Lecturers: Aliaksandr Birukou and Elisa Magistrelli

        - "Ciberconflitti"(0.8 CFU),
          Lecturer: Gian Piero Siroli, Francesco Vestito, Simon Pietro Romano, Daniele Amoroso

        - "L'Accademia delle Startup _ Le Startup dell'Accademia" (0.8 CFU),
          Lecturer: Lucia D'Arienzo, Daniela Pasquali, Massimo Varrone

        - "Scientific Programming and Visualization with Python" (3 CFU),
          Lecturer: Prof. Alessio Botta

        - "Big Data" (3 CFU),
          Lecturers: Prof. Antonio Picariello e Giancarlo Sperlì

        - "Artificial Intelligence for Energy and Environmental Systems" (0.8 CFU),
          Lecturer: Prof. Peter P. Groumpos

        - "Green Economy and Management in Engineering Projects (3 CFU),
          Lecturers: Prof. G.Zollo/L. Iandoli, C. Piccolo, G. Ferruzzi/P. De Falco, G.M. Mauro, P.Rippa

        - "Big Data Analytics and Business Intelligence" (6 CFU),
          Lecturer: Prof. Antonio Picariello.

b.   Seminars

- "Parallel and Distributed computing with MATLAB" (0.4 CFU).
  Lecturer: Ing. Stefano Marrone
  Organizer: Prof. Alessandra D'Alessio, 21/11/2018

- "An Introduction to Blockchains" (0.4 CFU).
  Lecturer: Dr. Ida Rejeki Siahaan
  Organizer: Prof. Piero Bonatti, 03/12/2018

- "Filtraggio dell'azimuth ambiguity in immagini SAR" (0.2 CFU).
  Lecturer: Ing. Gerardo Di Martino
  Organizer: Prof. Antonio Iodice, 07/12/2018

- "A principal component analysis approximation scheme for combinatorial optimization with uncertain and correlated data" (0.4 CFU).
  Lecturer: Prof. Fausto Errico
  Organizer: Claudio Sterle, 12/12/2018

- "Computational and machine learning methods for complex ecosystems" (0.2 CFU).
  Lecturer: Edoardo Pasolli
  Organizer: Antonia Tulino, 26/02/2019

- "Chaos in Magnetization Dynamics" (0.3 CFU).
  Lecturer: Prof. Caludio Sepico
  Organizer: Prof. Claudio Serpico, 26/02/2019

- "MATLAB Onramp and Sisotool" (0.6 CFU).
  Lecturer: Ing. Francesco Orefice
  Organizer: Prof. Antonio Picariello, 23/03/2019

- "MATLAB and Embedded Systems" (0.4 CFU).
  Lecturer: Ing. Stefano Marrone
  Organizer: Prof. Antonio Picariello, 28/03/2019

- "Methods for Explainable Learning, Lesson III" (0.4 CFU).
  Lecturer: Roberto Prevete
  Organizer: Roberto Prevete, 24/05/2019

- "Methods for Explainable Learning, Lesson V" (0.4 CFU).
  Lecturer: Roberto Prevete
  Organizer: Roberto Prevete, 29/05/2019

- "Methods for Explainable Learning, Lesson VI" (0.4 CFU).
  Lecturer: Roberto Prevete
  Organizer: Roberto Prevete, 31/05/2019

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- "PID Passivity-Based Control: Application to Energy and Mechanical Systems" (0.2 CFU).
  Lecturer: Romeo Ortega
  Organizer: Fabio Ruggiero, 21/06/2019

- "Innovation in medical robotics and the human-centred paradigm" (0.2 CFU).
  Lecturer: Ds. George Mylonas
  Organizer: Dr.ssa Fanny Ficuciello, 05/09/2019

- "Pathways to resilient solar buildings and communitiess" (0.5 CFU).
  Lecturer: Prof. Andreas K. Athienitis
  Organizer: Prof. Adolfo Palombo, 10/09/2019

- "Short Mediterranean Phd School, from 7 to 11 October 2019 (3 CFU).

3. Research activity

   a. Title: "C-ITS services and advanced vehicle control for complex traffic scenarios"

   b. Study: Smart and autonomous system, connected vehicles, virtual vehicle simulation platform.

   c. Research description

The transformation towards "Smart Roads" is underway in full harmony with the processes of governing and managing innovation in the sector in Europe, with reference to the European C-ITS Platform (Cooperative Intelligent Transport Systems; C-ITS), to the GEAR 2030 initiative and to the Smart Road Decree signed by the Italian Government in March 2018. The process involves the development and exploitation of key technologies for enabling innovative and automated driving functions and applications, as well as the design of demonstration scenarios in which automated driving functions are tested in various use cases. The main idea is to improve road safety and traffic flow, and to reduce congestion, fuel consumption and pollutant emissions.

New C-ITS (connected and fully automated) mobility services can also contribute to reducing overall traffic, making cities and human settlements safe, resilient, sustainable, and decrease the number of deaths and injuries caused by road accidents. An open challenge is related to the introduction of automated vehicles in existing traffic poses specific and new problems in terms of reliability and effectiveness, concerning interactions with other vehicles and/or other actors of the traffic scenario, such as pedestrians, public vehicles or cyclists. Furthermore, automated guidance systems must be appropriately designed to be resilient both to the uncertainties of V2X communication, to guarantee enough reliability and robustness in every traffic situation in the real world.

In this framework, my study focuses on the develop of cooperative strategies for cooperative vehicles, based on both onboard sensors and V2X communication, and test them in complex traffic contexts with high interaction between vehicles.

To develop these strategies, methodologies for cooperative and distributed control of multi-agent systems, advanced techniques for the control of cyber-physical systems and algorithms of Sensor Fusion were widely used.

The development of such cooperative strategies needs for testing and validation, due to a wide range of driving situations in which vehicles can be in.

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To easily test and validate these C-ITS strategies in any type of situation, I started to develop a light-weighted and open simulation platform, based on the integration of SUMO and Matlab/Simulink, so to have a realistic representation of Vehicle Dynamics and Surrounding Road Environment, and to quantify the impacts, benefits and costs of connected and automated vehicles driving systems in urban mixed traffic flow (connected human-driven and autonomous). In particular, Matlab/Simulink allows to manage Vehicle Dynamics, Sensors and Control Logics, and to create a simplified 3D road environment, while SUMO is used to recreate realistic road traffic conditions. The main advantages of such a tool are: 1) light-weighted tool, so no powerful hardware is needed to perform simulations; 2) low cost because no commercial software is required; 3) easily adaptable to developers needs.

I focus on urban intersection scenarios because their management is one of the most critical challenges in an urban environment because of: 1) stop&go phenomena and tight spacing affect road safety, increasing the probability of road accidents; 2) stops along trip increases travel time, fuel consumption and pollutant emissions.

Firstly, I study GLOSA (Green Light Optimal Speed Advisory), a C-ITS to improve mobility and reduce pollutant emissions, which exploits V2I communication to define an optimal speed profile to cross a TLS intersection, avoiding idle time. Two case studies have been analyzed to study the benefit of the service. The results show that even using a simple control algorithm, which has the aim to avoid the stop&go phenomena, is possible to observe a reduction of fuel consumption and pollutant emissions in the region of 5 to 12%. Subsequently, I focus on unsignalized intersection in mixed traffic flow conditions (autonomous connected vehicles and human-driven vehicles). This kind of scenario presents some critical issues: 1) No intersection priority; 2) presence of human-driven vehicles, which do not have information about all the vehicles approaching the intersection; 3) presence of occlusions in line of sight. To overcome these issues, I proposed a solution that exploits V2V communication and on-board ranging sensors capabilities to extend the line-of-sight of the vehicle. To validate the theoretical results, a case study has been analyzed. The results show, combining information obtained both from on-boards ranging sensors and V2V communication, that the controlled vehicle adapts its motion and crosses the intersection safely.

    d. Collaborations

- Research Group of Prof. Gennaro Nicola Bifulco (DICEA, Università di Napoli Federico II)
- Fiat Chrysler Automobiles group, FCA

4. Products

    a. Publications

        i. **Published:** "Motivating the need for an integrated software architecture for Connected and Automated Vehicles technologies development and testing" Luigi Pariota, Angelo Coppola, Luca Di Costanzo,Claudio D'Aniello, Gennaro Nicola Bifulco, in *MT-ITS2019 6th International Conference on Models and Technologies for Intelligent Transportation Systems,* 7/06/2019

        ii. **Published:** "Green Light Optimal Speed Advisory: a C-ITS to improve mobility and pollution" Luigi Pariota, Luca Di Costanzo, Angelo Coppola, Claudio D'Aniello, Gennaro Nicola Bifulco, in *2019 IEEE International Conference on Environment and Electrical Engineering and 2019 IEEE Industrial and Commercial Power Systems Europe (EEEIC/I&CPS Europe)*, 11/06/2019

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   iii. **To Be Published:** "Intersection Crossing in Mixed Traffic Flow Environment leveraging V2X information", Angelo Coppola, Bianca Caiazzo, Gennaro Nicola Bifulco, Stefania Santini, in 8th *IEEE International Conference on Connected Vehicles and Expo (ICCVE),* Graz (Austria), November 2019

5. Conferences and Seminars

   a. Details

   b. Presentations

      To Do: 8th IEEE International Conference on Connected Vehicles and Expo (ICCVE), Graz (Austria), November 2019

6. Activity abroad

   a. Details: Visitor at the Warsaw University of Technology on the 16th -17th July 2019. During the meeting current researches on autonomous vehicles in traffic scenarios were presented. It was possible to visit the Polish Motor Transport Institute and use a vehicle equipped with a Lidar to gather 3D scans of surrounding environment.

7. Tutorship

Subsidiary teaching activity, for the exercise lessons, in the course "ANALISI DEI SISTEMI" (ING-INF/04), for a total of 18 hours.

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	Credits year 1								Credits year 2								Credits year 3									
	Estimated	bimonth 1	bimonth 2	bimonth 3	bimonth 4	bimonth 5	bimonth 6	Summary	Estimated	bimonth 1	bimonth 2	bimonth 3	bimonth 4	bimonth 5	bimonth 6	Summary	Estimated	bimonth 1	bimonth 2	bimonth 3	bimonth 4	bimonth 5	bimonth 6	Summary	Total	Check
Modules	17.8	2	3	3	0.8	6	3	17.8	9.2							0	3							0	18	30-70
Seminars	8	1.4	0.5	1	1.4	0	3.7	8	2							0	0							0	8	10-30
Research	34.2	6.6	6.5	6	7.8	4	3.3	34.2	48.8							0	57							0	34	80-140
	60	10	10	10	10	10	10	60	60	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	60	180

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