

STUDENTS' ANNUAL ACTIVITY REPORT

CYCLE XXXV YEAR 2020

- Name and Surname: **HENRIQUE DE CARVALHO PINHEIRO**
- Dottorato in: **INGEGNERIA MECCANICA**
- Department: **DIMEAS**
- Coordinator: **Prof. Luca GOGLIO**
- Tutor: **MASSIMILIANA CARELLO**
- Macroarea: **Automotive – Innovative Electric and Hybrid Vehicles**
- Short description of research activity (maximum 20 lines)

Autonomous driving and ADAS are among the research trends in the automotive industry. SAE Level 4 autonomous driving has been achieved only for simple traffic system, as highways, while urban traffic represents a more demanding challenge due to its complexity with pedestrian, cyclists and less regulated road condition. However, even if fatal accidents cannot yet be completely avoided, strong improvement in urban scenario can lead to very significant results.

Alongside with ADAS, the electrification of passenger vehicles is an undeniable trend and the changes in the architecture and dynamic response of new electric vehicle must be taken in consideration for the virtual modelling and development of control systems and innovative mechanical components.

The research line is based on the implementation of an electrified powertrain to a mass market test vehicle, serving as platform for technology development. This road-legal prototype will be the base for the development of control strategies for dynamics improvement (e.g torque vectoring) and/or ADAS functionalities (e.g emergency braking, crash avoidance, lane keeping, assisted overtaking). The objective is to validate the multibody and virtual models built during the PhD and to create new control strategies that are both at the academic state-of-the-art and in harmony with the industrial and market needs in the near future.

The Research activity includes the topics: Drive systems powered by electric motors, Electric/hybrid vehicle energetic modeling, Vehicle dynamics, Experimental validation on track.

- Training activities carried out during the year (courses, seminars, etc.); for each activity specify the nature, duration, and location

Course	Hours	Location	Nature
Automotive transmissions (manual, non-manual and hybrid)	20 h	Politecnico di Torino	PhD Course – Hard Skills
Electrochemical power sources	20 h	Politecnico di Torino	PhD Course – Hard Skills
Entrepreneurship and start-up creation	40 h	Politecnico di Torino	PhD Course – Soft Skills
Innovation for Change (I4C)		PoliTo, CDI and CERN	
Human-Ai Interaction	20 h	Politecnico di Torino	PhD Course – Hard Skills
Hybrid propulsion systems	15 h	Politecnico di Torino	PhD Course – Hard Skills
Sustainable transport systems: energy and environmental issues	10 h	Politecnico di Torino	PhD Course – Hard Skills
Modeling complex systems in engineering and management	40 h	Politecnico di Torino	PhD Course – Hard Skills

- Possible participation in further research activities during the year (research projects and agreements)

Research Project	Funding	Duration	Partnership
Vehicle Dynamics Assessment for Autonomous Driving	FCA – CRF research projects with PoliTo	End in Mar/2020	FCA
ACTL 2 - Balestra trasversale in materiale composito per applicazioni automotive	Bando Poli di Innovazione - Agenda Strategica di Ricerca 2016 - Linea A	End in Feb/2020	SFC, MEC, Blue Engineering
PI2MAP - Piezoelectric sensors Integration on composite MA nufacturing P rocess for predictive MA intenance on structural composite P arts	MANUNET III	Apr/2020 – Apr/2022	SFC, FRACTAL, FRAP, MEC, ROLLAX

- Possible participation in internal activities to support teaching during the year (specify on which courses, named as “subject expert”)

Course	Professor	Hours	Role
Chassis B – 2 nd year MSc. Automotive Engineering	Massimiliana Carello	21h	Student's Tutoring and evaluation in the development of technical project and presentation

- Stays at other research institutions during the year

None

- Collaborations with companies during the year

Collaboration	Partnership
Co-funding of PhD Scholarship – Development of vehicle models, study of test vehicle electrification and bibliography research on control systems	Beond + CNR
ADAMS Car - Dynamic Performance Comparison Between In-Wheel and On-Board Motor BEVs	MSC
Car Real Time – Active Aerodynamics development and validation on driving simulator	VI-Grade

- List of accepted papers

Title	Journal/Congress	Status
Human-Driving Highway Overtake and Its Perceived Comfort: Correlational Study Using Data Fusion	SAE International Congress 2020	<u>Published</u>
Experimental Characterization of Piezoelectric Transducers for Automotive Composite Structural Health Monitoring	SAE International Congress 2020	<u>Published</u> <i>Best Papers Award</i>
Dynamic Performance Comparison Between In-Wheel and On-Board Motor Battery Electric Vehicles	ASME - IDETC2020	<u>Accepted</u> , presented (waiting publication)
Active Aerodynamics Through Active Body Control: Modelling and Static Simulator Validation	ASME - IDETC2020	<u>Accepted</u> , presented (waiting publication)
Advanced Vehicle Dynamics Through Active Aerodynamics and Active Body Control	ASME - IDETC2020	<u>Accepted</u> , presented (waiting publication)
Autonomous Driving Scenario Generation in Overtake Manoeuvres Through Data Fusion	IFIT 2020	<u>Published</u>
Active Aerodynamics Design Methodology for Vehicle Dynamics Enhancement	IFIT 2020	<u>Published</u>
City Car Drag Reduction by means of Flow Control Devices	SAE Brasil 2020	<u>Accepted</u> (waiting publication)
Integrated Design and Control of Active Aerodynamic Features for High Performance Electric Vehicles	SAE Brasil 2020	<u>Accepted</u> (waiting publication)

Date, 17/09/2020

Signature of Tutor

Signature of the Phd student

The Coordinator