POLITECNICO DI MILANO

PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 39th cycle

PNRR 117 Research Field: SYNCHRONIZING TYRE TORQUE DISTRIBUTION WITH ACTIVE CONTROLS TO MAXIMIZE DRIVING SAFETY

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	During the decades, the automotive sector has proven to be one of the most innovative. Nowadays, demanding targets concern safety, environmental impact, electric transition, sustainable mobility and autonomous driving. Emerging technologies and novel vehicle architectures provide engineers with new tools and opportunities to take up the challenge. Electric motors allow better control over driving and braking torques, enhancing the performance of systems like ABS, ESP or torque vectoring. Brake-by-wire or steer-by-wire eases the interaction between drivers and ADAS. Also, today's vehicles can collect more information about themselves, other vehicles, and the environment. Sensors can be miniaturized and distributed over the chassis or embedded in components like tires and bearings. A lot of information is thus available and, thanks to increased computational power and AI, can be profitably processed in real-time. New control strategies can be conceived, considering the coordination of different control systems or even of more vehicles. In addition, driving simulators are becoming popular development tools, allowing the testing of vehicles in a safe and controlled environment. They can significantly reduce the time-to-market of a product. The target of the research consists of designing and testing novel control systems involving brakes actuation that exploit the opportunities enabled by new technologies.
Methods and techniques that will be	The research programme focuses on the design,

developed and used to carry out the research	The research programme focuses on the design, development, and testing of control systems that exploit novel sensing devices, novel actuators and integration among different controls. The brake system will represent a fundamental element of the control system. The idea is to properly coordinate the intervention of the brake system with those of other control systems to exploit synergies and improving overall safety and performance. New vehicles layouts offering independent control of the corners in terms of driving/braking torques and steer angle, will be considered. In the first stage, the control system will be developed in a virtual environment where it will interact with a mathematical model of a vehicle. Besides describing the vehicle dynamics, this model will have to properly reproduce the behaviour of subsystems like: brake system, steering system, transmission-powertrain, suspensions, tyres and aerodynamics. The innovative control systems will be integrated in this environment, developing models for the control logic, the actuating and sensing devices and, possibly, V2X communication. Modelling skills will be developed in this stage, also focusing on real-time application. Then, the control logic will be optimized off-line in the virtual environment through a series of numerical simulations. Knowledge of optimization techniques and identification of proper KPI will be required in this phase. After this stage, the interaction between the control system and the human driver will be tested. Test sessions at the dynamic driving simulator are planned: control parameters will be optimized and possibly tuned on specific driver profiles. Fault injection will be also considered to develop proper mitigation logics.
Educational objectives	At the end of the programme, the candidate will be an expert in vehicle dynamics, vehicle architecture and its subsystems, sensor devices, V2X communication, signal processing, active control systems and ADAS. The candidate will actively support the design and development of a control system, from its modelling and integration in a virtual environment to the driving simulator tests. Therefore, the engineer will develop state-of-the-art knowledge of methodologies, components, and

	developing tools. In addition, the candidate will spend six months at the company under the direct supervision of the industrial tutor. This experience will allow him to get familiar with the industrial environment and the development workflow.
Job opportunities	Considering the topic of the research and the expertise developed, the candidate will find job opportunities in the automotive field. Our last survey on MeccPhD Doctorates highlighted a 100% employment rate within the first year and a 35% higher salary, compared to Master of Science holders in the same field.
Composition of the research group	1 Full Professors 1 Associated Professors 0 Assistant Professors 0 PhD Students
Name of the research directors	Prof. Stefano Melzi

Contacts
For questions about scholarship/support please contact phd-dmec@polimi.it

Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	BREMBO S.p.A.
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	to be defined
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

Financial aid is available for all PhD candidates (purchase of study books and materials, fundingfor participation in courses, summer schools, workshops and conferences) for a total amount of euro 5.707,13.

Our candidates are strongly encouraged to spend a research period abroad, joining high-level research groups in the specific PhD research topic, selected in agreement with the Supervisor. An increase in the scholarship will be applied for periods up to 6 months (approx. 700 euro/month- net amount).

Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD candidate. There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.