POLITECNICO DI MILANO

PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 38th cycle

Research Area n. 3 - Engineering Design and Manufacturing for the Industry of the Future

PARTENARIATO PNRR Research Field: ADVANCED METHODS AND TECHNOLOGIES FOR IMPROVED ACTIVE SAFETY AND USER EXPERIENCE IN SUSTAINABLE MOBILITY

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	In response to the COVID-19 pandemic, the field of light vehicles and active mobility has seen a rapid growth which is expected to continue in the coming decades. The increasing popularity of active multimodal mobility is largely due to the widespread availability of powered two-wheelers, including e-mopeds, e-bikes, e-scooters as well as advanced human-machine interfaces that facilitate interaction with the environment. This creates a connected ecosystem of vehicles, services, infrastructure and individuals. Active and light mobility offers several key benefits, including: door-to-door convenience; sustainability compared to single-occupancy vehicles in both urban and rural areas; low energy consumption and zero to low energy requirements; increased social accessibility and affordability; time and space savings, reducing the environmental, economic and social costs of traffic congestion and land usage; quick time-to-market for vehicles and infrastructure; promotion of sustainable and healthy lifestyles; encouragement of cycling and sustainable tourism. Despite being protected by regulations, safe lanes and a well-established culture, light vehicles and active mobility are considered the most vulnerable road users and are at a higher risk of negative consequences in the event of an accident. To address this, safety is the primary concern and encompasses

	vehicle safety, infrastructural safety and user safety. Key enabling technologies such as energy storage systems, sensors, the Internet of Things- IoT, Vehicle-to-everything - V2X communications and advanced materials also play a critical role in ensuring the safety of these vehicles and their users. This research project is focused on the analysis of users' behavior in terms of driving style, route choice and overall well-being and on the development of sensors and IoT technologies for light and active vehicles to improve active safety and enhance the overall user experience. The data collected will be used to support the development of vehicles and infrastructure and to meet needs and demands of target users. The research activity is developed within the National Center for Sustainable Mobility (*Centro Nazionale per la Mobilità Sostenibile*) - Spoke 5 (Light Vehicles and Active Mobility), as part of the National Plan for Recovery and Resilience (PNRR, M4 C2 *Dalla ricerca all'impresa*). Norms of reference: CUP D43C22001180001 - D.D. 1033 del 17/06/2022 D.D. 3138 del 16/12/2021 rettificato con D.D. 3175 del 18/12/2021 Avviso pubblico per presentazione di Proposte di intervento per il Potenziamento di strutture di ricerca e creazione di campioni nazionali di R&S su alcune Key Enabling Technologies da finanziare nell'ambito del Piano Nazionale di Ripresa e Resilienza, Missione 4 Componente 2 Investimento 1.4, finanziato dall'Unione Europea - NextGenerationEU.
Methods and techniques that will be developed and used to carry out the research	The present research involves the development of: - methods and tools that analyze the driving styles of users in order to (i) improve the vehicle comfort, (ii) optimize the electric assistance of the vehicle in favor of a balance between human and electric traction, (iii) optimize the planning of the active mobility network including EVSE and service location, (iv) promote a multi-modal transportation, (v) improve the safety and comfort of roads and infrastructures.

	- methods and tools that detect potentially dangerous behaviors of the users and develop optimal countermeasures, with a focus on both vehicle stability and interaction with the infrastructure/environment. - sensor systems, IoT technologies and V2X networks for active mobility. The goal is to enhance the overall user experience and to enable the monitoring of vehicles, environment and users, including fault detection, predictive maintenance, obstacle detection, air quality, physiological signals, stress and fatigue estimation. - methods and tools that promote the correct use of light vehicles (in current and future mobility contexts) to ensure safety for riders, other mobility users, and other vehicle drivers. Particular attention will be paid to the use of innovative technologies for the analysis of users' driving styles (e.g. eye tracking, smartwatches, virtual/augmented reality visors, wearable sensors, etc), for the improvement of the safety of light vehicles (e.g. ADAS sensors, haptic devices, connected instruments etc.) and for the analysis of the interactions with the infrastructure (e.g. HMI, drones, etc.). These aspects will be tested in a laboratory environment and during real-world experiments in urban or touristic scenarios with willing and aware users.
Educational objectives	The program has the primary goal of producing highly skilled researchers who can make significant contributions to the field of mobility through the creation of new knowledge. The program seeks to train researchers who can develop practical tools and methods to improve mobility systems and services and who possess the ability to critically analyze these systems from various perspectives. Key educational objectives include: - the ability to analyze transportation supply and demand and their interrelationships; - a thorough understanding of user behavior in vehicles, including their psychophysical state and perception of their surroundings, and an ability to evaluate the implications of these behaviors in terms of safety; - the skills necessary to design and optimize sustainable transportation systems based on light vehicles and active

	mobility.
Job opportunities	The activity will be carried out in collaboration with industrial partners such as Brembo, Pirelli, Poste Italiane and SITAEL Angel Company and will involve also researchers from other departments of Politecnico di Milano (DEIB, DASTU and DESIGN), as well as from other universities (UniBG, UniBS and UniFI). 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. Therefore, at the end of the course, the researcher will gain the skills and experience to be able to enter various professional work and research fields. These are some examples of potential job opportunities for the researcher: - Academic Researcher in universities, research institutions, or academic organizations; - Data Scientist for analysing data related to users and their behaviour, as well as for implementing advanced data analytics algorithms; - Mobility Engineer for designing and developing new sensors and IoT technologies to enhance the performance and safety of vehicles; - Product Manager in the automotive or technology industry, responsible for product strategy and development; - Mobility Consultant for working with companies and government organizations to improve transportation systems; - Research Manager in R&D organizations or departments, taking on leadership roles in managing research projects and developing new technologies in the field of sustainable mobility; - Transportation Planner for planning and designing sustainable and efficient transportation networks; - Safety Engineer for designing and developing advanced safety features to enhance the overall user experience in vehicles.

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Composition of the research group	1 Full Professors 2 Associated Professors 1 Assistant Professors 3 PhD Students
Name of the research directors	Prof. Gaetano Cascini

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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

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, funding for 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.