



PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 41st cycle

THEMATIC Research Field: INNOVATIVE METHODOLOGICAL APPROACHES IN WEARABLE TECHNOLOGIES FOR HEALTH, WELLBEING AND SPORT

Monthly net income of PhDscholarship (max 36 months)
€ 1500.0
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	<p>Wearable technologies have been rapidly evolving into multidisciplinary tools with applications addressing health monitoring, sports performance optimization, and personalized wellbeing interventions. In fact, recent methodological innovations in wearable technologies have been driving important transformations in several domains; cuttingedge approaches now combine advanced sensor systems integrated with AI models to provide realtime personalized health monitoring, rehabilitation program optimization, stress management, and injury prevention prevention within the occupational settings. New solutions—like smart textiles—enhance device comfort, accuracy, and seamless integration with the human body, making continuous data collection less intrusive. These innovations are able to empower rehabilitation processes by providing dynamic, realtime feedback that helps tailor therapeutic interventions and accelerate recovery. Moreover, advanced prosthetics are increasingly incorporating wearable sensor arrays and haptic feedback mechanisms—often embedded in etextiles—to deliver more natural control and better adaptation to individual users’ needs. Furthermore, wearable systems are increasingly being integrated in sport with digital coaching platforms, enabling tailored training regimens and proactive performance management.</p> <p>The integration of physics-informed AI models has been further paving the way for robust and explainable data</p>



	<p>analytics, ultimately bridging the gap between raw sensor data and actionable health insights. Indeed, these methodological advances are fostering a shift towards proactive, datadriven, and personalized approaches in healthcare and wellbeing and sports. On the other hands, when focusing on health, wellbeing and sport, particular attention must be given to data privacy and security, integration and interoperability, user comfort and overall adoption, cost and accessibility. The proposed research aims to address the current technological limitations, interdisciplinary integration challenges, and real-world implementation gaps regarding the defined domains. In particular, the proposed research thence aims at targeting different challenges defined for each specific domain, including:</p> <ul style="list-style-type: none"> - definition of specific scenarios and use cases, where wearable technologies can provide an enabling role; - up-to-date analysis of the wearable technologies present in the current scientific literature and on the market, for those specific scenarios; - design and development of new methodological approaches in implementing wearables, including digital solutions, e-textile, AI and digital human modelling; - iterative implementation and verification of the proposed approaches, through design-based research; - validation of the developed approaches within the defined scenarios.
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>An inherently multidisciplinary approach will be implemented during the development of the research activities; this approach combines advanced digital technologies, e-textile, AI, digital human modelling and a deep knowledge of the application domains integrated with design methods to ensure effectiveness of the proposed solutions. Therefore, key techniques, include:</p> <ul style="list-style-type: none"> •definition of proper scenarios of interest with different use cases and users; •implementation of a systematic review of the current solutions and of a formal analysis of the current approaches identifiable on the market for each identified scenario;



	<ul style="list-style-type: none"> •adoption of specific design frameworks like Design-Based Research (DBR) to bridge engineering and user experience, within specific use cases, ensuring effective development/refinement processes through the use of advanced prototyping technologies; •integration of advanced signal processing techniques and modelling; •implementation of physics-informed AI models and digital human modelling solutions able to support the definition of predictive approaches for monitoring, injury prevention, performance optimization and personalized intervention during rehabilitation; •evaluation of ethical issues and data integrity; •assessment of translational impact <p>This methodological framework aligns with emerging needs in precision health, sustainable technology, and evidence-based sports science, providing a roadmap for advancing the current state-of-the-art of wearables.</p>
<p>Educational objectives</p>	<p>The educational objectives are addressing both technical-scientific and soft skills and expertise. In particular, the technical-scientific ones, include:</p> <ul style="list-style-type: none"> - gaining in-depth knowledge of sensor systems, e-textiles, digital human modeling, and advanced AI techniques, particularly physics-informed models; - developing interdisciplinary literacy and familiarity with the principles of healthcare, sports science, and personalized wellbeing to bridge engineering innovations with domain-specific needs; - learning how to conduct comprehensive reviews of both academic literature and market solutions to identify gaps and current trends in wearable technology; - developing skills to define, model, and analyze specific scenarios and user cases where wearable technologies can be most effectively applied; - mastering design-based research (DBR) methodologies to iteratively design, develop, and refine prototypes in real-world contexts, so as ensure the development of comfortable and accessible solutions that can be seamlessly integrated into users' lives, thus promoting



	<p>higher adoption rates;</p> <ul style="list-style-type: none"> - engage in hands-on development and testing of wearable systems, integrating digital solutions and e-textiles with AI models for continuous feedback; - acquiring expertise in processing and analyzing complex sensor data, enabling real-time monitoring and feedback; - develop and validating predictive models that leverage AI and, more in details, physics-informed AI to optimize rehabilitation, performance management, injury prevention, etc. - develop and validating digital human models that can support the identification of specific metrics to predict specific behaviours; - learning the ethical and legal frameworks surrounding data integrity, privacy, and security, ensuring that wearable solutions comply with regulatory standards. - learning methods for iterative testing and real-world validation of prototypes within defined scenarios, including the use of pilot studies within clinical contexts, so as to assess the broader impact of technological innovations, translating laboratory findings into practical, scalable solutions in healthcare and sports. <p>The educational objectives concerning soft skills, include:</p> <ul style="list-style-type: none"> - developing competencies in managing collaborative projects that involve engineers, clinicians, sports scientists, and designers; - enhancing skills in effectively communicating complex technical and research findings to both academic and non-technical audiences, ensuring proper knowledge transfer. All these objectives are designed to ensure that the PhD candidate not only develops deep technical expertise but also gains a holistic understanding of the socio-ethical, methodological, and translational aspects necessary for advancing wearable technologies in precision health, sustainable technology, and evidence-based sports science.
<p>Job opportunities</p>	<p>Given the inherently multidisciplinary nature of the proposed research, the PhD student will have the opportunity to collaborate closely with professionals from diverse fields, including engineering, healthcare, sports science, human-computer interaction, and design. This</p>



	<p>collaborative environment will serve as a foundation for developing the ability to work effectively within interdisciplinary teams—an essential skill in both academic and industry research settings. Throughout the PhD journey, the candidate will progressively build strong competencies in managing complex research workflows, from the ideation and prototyping phases to iterative testing and real-world validation. This will foster a high degree of autonomy, enabling the student to take ownership of the creative and methodological processes that underpin innovative technological solutions. By the conclusion of the PhD, the student will be equipped with a comprehensive skill set that supports career opportunities both within academia and in industry. Specifically, they will be well-prepared for roles in research and development departments of companies working on wearable technologies, digital health solutions, smart textiles, and AI-driven sports and rehabilitation platforms—sectors that are rapidly expanding in today’s job market. Moreover, the mandatory international research internship will provide valuable exposure to global research environments, significantly broadening the student’s professional network and enhancing their employability. The student will also actively participate in national and European research projects, often involving large consortia of universities, research centers, and companies. These collaborative initiatives will further strengthen their experience in project management, multidisciplinary teamwork, and translational research, while also opening doors to long-term career opportunities in innovation-driven sectors.</p>
Composition of the research group	<p>2 Full Professors 1 Associated Professors 1 Assistant Professors 3 PhD Students</p>
Name of the research directors	<p>Proff. M. Tarabini, G.Andreoni, N. F. Lopomo</p>

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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents	--

Scholarship Increase for a period abroad	
Amount monthly	750.0 €
By number of months	6

Stage and period abroad	
Institution or company where the candidate will spend the period abroad (name and brief description)	
By number of months abroad	0

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 € 6.114,50. 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. 750 euro/month- net amount). Additionally, PhD candidates who spend at least 3 months abroad are eligible for an extra reimbursement of €3,000 to cover travel expenses. 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.