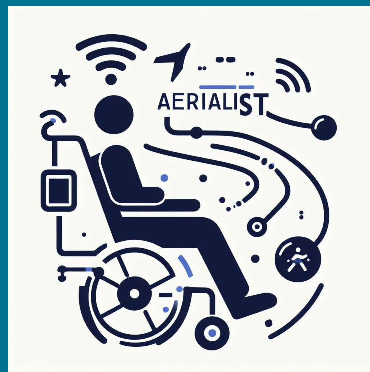
15 PhD positions in the Horizon Europe Marie-Curie Doctoral Network:



European Doctoral Network on Assistive Health Technology in Unsupervised/Home Settings

Applications are invited for 15 PhD positions ("Doctoral Candidates", DCs). This includes 13 positions funded by the Marie-Skłodowska-Curie within the Horizon Europe programme of the European Commission. In addition, there will be 2 extra positions funded by SERI Switzerland. These positions will all be part of the Marie-Skłodowska-Curie's "Doctoral Network on Assistive Health Technology in Unsupervised/Home Settings - AERIALIST".In an era marked by groundbreaking innovations within assistive health technologies, people with motor disabilities have the prospect of achieving better health out-comes, enhanced treatment, improved quality of life, and increased participation in daily activities. This new way of healthcare has far-reaching implications, touching the lives of a diverse spectrum of individuals, from the expanding elderly population, two out of three requiring at least one assistive product, to patients and healthy individuals navigating the challenges of automated work environments. Noteworthy examples include deploying rehabilitation robotics for homebased treatment, electric wheelchairs facilitating independent mobility, telehealth applications for cardiovascular monitoring, and powered prostheses restoring mobility and confidence in various daily life activities. The **AERIALIST Doctoral Network on Assistive Health Technology in Unsupervised/Home Settings** takes on the challenge of advancing assistive health technologies to provide adaptive, reliable, and intelligent solutions. Our mission is to create systems that seamlessly adapt to users, environments, and tasks, offering human- like, intuitive, and symbiotic assistance. To achieve this, our research leverages the vast potential of recent theoretical machine-learning developments, translating them into real-world physical interactions between humans and engineering systems.

The positions within the network are located at KU Leuven (BE), Leibniz Universität Hannover (DE), Fraunhofer-IESE (DE), Tyromotion (AT), Ottobock (AT), PLUX (PT), Consejo Superior de Investigaciones Científicas (ES), Wearable Robotics (IT), Scuola Superiore Sant'Anna (IT), Rheinisch-Westfälische Technische Hochschule (DE), . Together, these bring in top-class expertise in Human–computer interaction, Rehabilitation robotics, biomechanical engineering, Neuromuscular electrical stimulation therapy, Systems safety engineering, Fault-tolerant computing, AI and ML for control and Sensing, Sensor fusion, Biosensor, Sensorimotor control and Model Predictive Control as well as domain knowledge of relevant application sectors. Furthermore, the inter-sectoral characteristic is guaranteed by the support of a series of industrial and medical entities, such as Universitätsklinik Balgrist, REHA-STIM MEDTEC AG, MEDISANTE GROUP AG, SensorStim Neurotechnology GmbH, FUNDACION HOSPITAL NACIONAL DE PARAPLEJICOS, ERASMUS UNIVERSITAIR MEDISCH CENTRUM ROTTERDAM, forming a fully interrelated, integrated, and international consortium.

Key dates:

- **23 September 2024: Launch of 15 DC Positions**
- **November-December 2024: First selection procedure (screening received applications and first online interviews)**
- **10 January 2025: Deadline for online application**
- **11 January - 9 February 2025: Second selection procedure – screening received applications**
- **10 February 2025: Circulation list "AERIALIST preselected candidates Recruitment Event"**
- **Beginning of March 2025: AERIALIST Recruitment Event**
- **1 week after Recruitment Event: Circulation list "recruited AERIALIST DCs"**
- **April - November 2025: Targeted starting date for DC contracts**

Key background info

EU FUNDING

This project has received funding from the European Union's EU Framework Programme for Research and Innovation under the HORIZON-MSCA-2023-DN Grant Agreement N°101169197 (MSCA-DN-AERIALIST)

Number of positions available
15 PhD Positions

Research Fields
Control Engineering - System Engineering - Sensor Engineering - Computer Science – Signal Processing – Safety Engineering – Biomechanical Engineering

Keywords
Systems engineering, sensorics, actorics, automation – Sensing – Intelligent robotics, cybernetics – Medical engineering and technology - Machine learning - statistical data processing - anomaly detection

Career Stage
Doctoral Candidate (DC)

Benefits and salary
The successful candidates will receive an attractive salary in accordance with the MSCA regulations for DCs. The gross salary includes a **living allowance** (approximately € 3400 per month[1]), a **mobility allowance** of approximately € 600 per month and, if applicable, a **family allowance** of approximately € 660 per month. ***These amounts are nominal (gross) amounts and certain deductions will apply for social security contributions and/or taxes according to the applicable national laws of the country where the recruiting beneficiary is located***. The exact (net) salary will be confirmed upon appointment and is dependent on local tax regulations and on the country correction factor (to allow for the difference in cost of living in different EU Member States). The guaranteed PhD funding is for 36 months (i.e. EC funding, additional funding is possible, depending on the local Supervisor, and in accordance with the regular PhD time in the country of origin). In countries where PhDs typically last longer than 36 months, beneficiaries commit themselves to foresee additional funding for the required time to finish the PhD if the DC fulfils all technical requirements at the end of the 36 months. In addition to their individual scientific projects, all fellows will benefit from further continuing education, which includes internships and secondments, a variety of training modules as well as transferable skills for the Jobs of Tomorrow as well as active participation in workshops and conferences.

On-line Recruitment Procedure (see Appendix 1 for full description)
All applications proceed through the on-line recruitment portal on the dn-aerialist.eu website. Candidates apply electronically **for one to maximum three DC positions** and indicate their preference. Candidates provide all requested information including a detailed CV (Europass format[2] obligatory), a motivation letter and transcripts of bachelor and master degree[3]. During the registration, applicants will need to prove that they are eligible (cf. DC definition, mobility criteria, and English language proficiency). For some positions, candidates must be eligible with respect to national and international regulations for knowledge transfer and export control. **The (final) deadline for the online registration is 10 January 2025**. However, candidates are encouraged to apply as soon as possible. In the period November-December 2024 a first selection procedure will take place where received applications so far will be screened by the respective beneficiaries and possible first online interviews might take place along with online personality tests. Additionally, after the online application deadline (10 January 2025), a second selection procedure will take place, similar as the one during the first selection procedure. Finally, the AERIALIST Recruitment Committee selects between 20 and maximum 30 candidates for the Recruitment Event which will take place in Bruges (Belgium) (**Beginning of March 2025**). The selected candidates provide a 20-minute presentation and are interviewed by the Recruitment Committee. Candidates will be given a small scientific task (prior to the recruitment event) by their prioritized Supervisor and will be asked questions about this task during the interview to check if the candidate has the right background/profile for and a good view on the DC position. In order to facilitate their travel, selected candidates (from outside Belgium) receive a reimbursement of maximum 250 euro (paid by the prioritized Supervisor). In order to avoid delays in reimbursements, candidates are asked to keep all invoices and tickets (cf. train, plane, hotel...). The final decision on who to recruit is communicated shortly after the Recruitment Event (estimated **1 week after the Recruitment Event**). The selected DCs are to start their research as quickly as possible (target period: April – November 2025).

Applicants need to fully respect three eligibility criteria (to be demonstrated in the Europass CV):

1. **Doctoral Candidates** (DCs) are those who are, at the time of recruitment by the host, **not already in possession of a doctoral degree**.
2. **Conditions of international mobility of researchers**: Researchers are required to undertake transnational mobility

[1] Dependent on the applicable EU Country Coefficient
[2] https://europass.cedefop.europa.eu/documents/curriculum-vitae
[3] Master students who will graduate in the next coming months are welcome to apply. In that case, please provide an overview of the transcripts that are already available.

(i.e. move from one country to another) when taking up the appointment. **At the time of selection by the host organisation, researchers must not have resided or carried out their main activity (work, studies, etc.) in the country of the recruiting beneficiary for more than 12 months in the 3 years immediately prior to their recruitment**. Short stays, such as holidays, are not considered.

3. **English language**: Doctoral Candidates (DCs) must demonstrate that their ability to understand and express themselves in both written and spoken English is sufficiently high for them to derive the full benefit from the network training.

The 15 available PhD positions

(see **Figure 2** for interactions between DCs/WPs)

DC1: Application of system thinking and system safety to head-foot steering system for your powered wheelchair
Host: KUL (BE)
Main supervisor: D. Pissoort (davy.pissoort@kuleuven.be)
Co-supervisors/mentors: M. Bolliger (UZH - CH), J.C. Moreno (CSIC - ES)
Duration: 36 months
Required profile: Electrical Engineering or Computer Science
Desirable skills/interests: Systems Engineering - Safety Assurance – Systems Thinking – Risk Analysis
Objectives: Formulate a novel hazard analysis methodology integrating STAMP and STPA, involving human interaction in the assessment of powered wheelchair risks; Assess the efficacy of the developed methodology through application to two distinct use case studies.

DC2: Ensuring Runtime Safety: A Digital Twin Approach for ML-Based Controllers
Host: Fraunhofer-IESE (DE)
Main supervisor: R. Adler (rasmus.adler@iese.fraunhofer.de)
Co-supervisors/mentors: P. Koppenhagen (Johner Institute - DE), G. Lunzenfichter (Medisanté – CH)
Duration: 36 months
Required profile: Software Engineering
Desirable skills/interests: Safety, Digital Twins, Data Science
Objectives: Create digital twin technology for individuals using assistive health technolgy devices to enhance real-time safety assurance of machine learning-based controllers; Assess the effectiveness of the developed methodology through a comprehensive evaluation in a single-use case study.

DC3: A EMI Risk management of Assistive Health Technology
Host: KUL (BE)
Main supervisor: D. Vanoost (dries.vanoost@kuleuven.be)
Co-supervisors/mentors: M. Kok (TU Delft - NL), M. F. Russold (OBHP – AT)
Duration: 36 months
Required profile: Electrical Engineering
Desirable skills/interests: Electromagnetic Compatibility – Electromagnetism – Sensors – Measurement Techniques
Objectives: Create and deploy continuous monitoring systems for electromagnetic disturbances in assistive devices during operation, with the ability to detect and respond to unexpected high disturbances to ensure safety and reliability.

DC4: Probabilistic, data-driven sensor fusion for reliable human-robot sensing under real-life conditions
Host: RWTH (DE)
Main Supervisor: H. Vallery (h.vallery@irt.rwth-aachen.de)
Co-supervisors/mentors: M. Kok (TU Delft - NL), H.J.G van den Berg-Emons (EMC - NL)
Duration: 36 months
Required profile: Completed university degree in mechanical engineering, electrical engineering, automation engineering or computer science (master's degree or comparable).
Desirable skills/interests: Very good knowledge of control and automation engineering or data science including but not limited to fundamentals of sensor fusion and data-driven modelling (ML). Good understanding of mechanics. Previous experience with the integration of IMU sensors and the interpretation of related data. Interest in the crossways between automation engineering and health technologies. Ability to work independently in a scientific context, while exceling in inter-institutional and interdisciplinary collaborations. Good oral and written English skills.
Objectives: Create probabilistic sensor fusion algorithms for accurate human-robot motion estimation, integrating all available sensor data and providing uncertainty insights, especially in scenarios where obtaining complete physics-based models is challenging.

DC5: Optimising Real-Time Multimodal Data Collection for Assistive Technology
Host: KUL (BE)
Main supervisor: H. Hallez (hans.hallez@kuleuven.be)
Co-supervisors/mentors: G. Rauter (UNIBAS - CH), H. Plácido da Silva (PLUX - PT)
Duration: 36 months
Required profile: Electrical Engineering or Computer Science
Desirable skills/interests: Sensorbased algorithm – Edge Computing - TinyML - distributed machine learning
Objectives: Research and gather field-based use cases for assistive health technology, emphasizing reliable sensors, logic, and com- munication devices to collect raw data. Explore the use of edge computing and distributed machine learning on embedded devices to improve cloud services.

DC6: Biomimetic model-based reinforcement learning of motor primitives
Host: LUH (DE)
Main supervisor: T. Seel (thomas.seel@imes.uni-hannover.de)
Co-supervisors/mentors: S. Ferrante (POLIMI - IT), D. Laidig (SensorStim – DE)
Duration: 36 months
Required profile: Background in control systems and machine learning, experience with Matlab or Python or both
Desirable skills/interests: Prior knowledge on real-time/embedded systems and biomechanics, interest in biomedical engineering and neuroprosthetics
Objectives: To design and implement autonomous learning control schemes for assistive health systems by creating iterative learning strategies that enable reinforcement learning on small amounts of experimentally gathered data, to rapidly achieve accurate motor primitives.

DC7: Fusion of Electrical Stimulation with the Wearable Robot
Host: CSIC (ES)
Main supervisor: J.C. Moreno (jc.moreno@csic.es)
Co-supervisors/mentors: T. Seel (LUH – DE), A. de Los Reyes (FUHNPAIN – ES)
Duration: 36 months
Required profile: Control Engineering or Robotics
Desirable skills/interests: HW/SW systems integration – biomechnical modelling – machine learning – electrical stimulation
Objectives: To develop biomimetic control strategies for active muscle recruitment via neuromuscular stimulation to augment mechanical motion support in wearable robotic exoskeletons for rehabilitation of walking.

DC8: Sensing the intention to move in people with neurological movement disorders
Host: UZH (CH)
Main supervisor: M. Bolliger (marc.bolliger@balgrist.ch)
Co-supervisors/mentors: M. Kok (TU Delft - NL), P. Freund (BAL - CH)
Duration: 36 months
Required profile: Electrical Engineering or Movement Science
Desirable skills/interests: Sensors – Measurement Techniques – Movement Analysis
Objectives: Investigate real-time motion intention detection in individuals with neurological movement disorders using sensor-based methods, develop algorithms for a wearable system that assesses real-time 3D human motion assessment, and explore its use in controlling assistive technology.

DC9: Situation-aware controller selection for robot-assisted overground gait training
Host: UNIBAS (CH)
Main supervisor: G. Rauter (georg.rauter@unibas.ch)
Co-supervisors/mentors: P. Rostalski (FGH IESE - DE), D.Surdilovic (RSM - CH)
Duration: 36 months
Required profile: Master's degree in the field of Biomedical Engineering or Robotics
Desirable skills/interests: Therapeutic/medical therapy, gait analysis, mechatronic systems, Human–computer interaction, Sensorimotor control
Objectives: Close the loop of robot-assisted gait rehabilitation supported by situation-aware controllers that are selected during task performance by real-time machine learning algorithms.

DC10: Co-Adaptive Data-Driven Modeling for Precision Motion Control in Powered Exo-aid
Host: SSSA (IT)
Main supervisor: A. Filippeschi (alessandro.filippeschi@santannapisa.it)
Co-supervisors/mentors: H. Vallery (RWTH - DE), I. Jakob (TYRO - AT)
Duration: 36 months
Required profile: Applicants should hold an MS degree in Engineering, preferably in Robotics, or Computer Science, and have a solid background in machine learning/AI. Good communication skills in English are mandatory.
Desirable skills/interests: Ideal applicants are enthusiastic about working with robots and sensor networks and like to experiment with their algorithms with humans in the loop. Analytical ways of thinking while being curious and creative are desirable skills for conducting research activities on this topic. Programming skills (C/C++, Python, Matlab/Simulink) are fundamental to successfully achieving the objectives. A good knowledge of robotics is desirable as well.
Objectives: One of the main challenges in human-exoskeleton interaction is accounting for human behavior in the control of the exos. A control action purely based on physical models struggles to cope with the variability of the user's input. The objective of this DC is to combine physics-based modeling with data-driven probabilistic machine-learning techniques to learn models of unknown human inputs from data and use these models in a closed-loop system to improve motion control in powered exo-a

DC11: Experience-Driven Co-Adaptation through Multi-Agent Learning in Assistive Devices
Host: LUH (DE)
Main supervisor: T. Seel (thomas.seel@imes.uni-hannover.de)
Co-supervisors/mentors: R. Riener (ETH - CH), F. Salsedo (WR - IT)
Duration: 36 months
Required profile: Background in control systems and machine learning, experience with Matlab or Python or both
Desirable skills/interests: Prior knowledge on multi-agent systems and biomechanics, interest in biomedical engineering and exoskeletons
Objectives: Implement multi-agent learning and explore the transfer of common data and experiences between individual systems and users.

DC12: Wearable sensors for health monitoring and assistive communication
Host: PLUX (PT)
Main supervisor: H. Plácido da Silva (hsilva@plux.info)
Co-supervisors/mentors: H. Gamboa (FCT NOVA - PT), M. Bolliger (UZH - CH)
Duration: 36 months
Required profile: Electronics engineering, Biomedical engineering, or a related field. A solid understanding of electronics circuit design and biosignal processing.
Desirable skills/interests: Experience with analogue/digital electronics design, signal conditioning and acquisition circuits design, circuit simulation in SPICE, PCB CAD Design, statistical analysis, and programming languages such as Python, MATLAB is required. Machine learning algorithms for biosignal analysis.
Objectives: To develop and evaluate wearable sensors that utilize biosignals for assistive communication and health monitoring, with the aim of enhancing autonomy and improving disease management for individuals with mobility limitations. These sensors will provide real-time data to facilitate better decision-making and personalized care, ultimately improving the users' quality of life..

DC13: In-Game Assessment for Patient-adaptive Intelligent Rehabilitation Robotics
Host: TYRO (AT)
Main supervisor: I. Jakob (iris.jakob@tyromotion.com)
Co-supervisors/mentors: T. Seel (LUH - DE), A. Turolla (Univ. of Bologna – IT)
Duration: 36 months
Required profile: Master's degree in field Biomedical Engineering or Robotics or Computer Science or Neuroscience.

Desirable skills/interests: data fusion and learning algorithms – therapeutic/medical therapy – virtual reality (VR) – mechatronic systems, especially robotics and sensor technology.
Objectives: Improve independence of robot-assisted therapy for unsupervised home settings.

DC14: Advancing Prosthetic Limb Control: Bridging the Gap Between Adaptability and Safety
Host: OBHP (AT)
Main supervisor: M.F. Russold (michael.russold@ottobock.com)
Co-supervisors/mentors: T. Seel (LUH - DE), D. Pissoort (KUL - BE)
Duration: 36 months
Required profile: Master's degree in the field of Biomedical Engineering or mechatronic or Robotics or Computer Science
Desirable skills/interests: Human-centred mechatronic engineering, Systems Engineering - Safety Assurance– Risk Analysis, control, Medical engineering
Objectives: Push forward prostehic limb technology by addressing current challenges in control.

DC15: User-centred model predictive control approach for robotic assistance
Host: WR (IT)
Main supervisor: F. Salsedo (f.salsedo@wearable-robotics.com)
Co-supervisors/mentors: A. Filippeschi (SSSA - IT), H. Hallez (KUL - BE)
Duration: 36 months
Required profile: Applicants should hold an MS degree in Engineering, preferably in Robotics, or Computer Science, and have a solid background in control and/or optimization. Good communication skills in English are mandatory.
Desirable skills/interests: Applicants should have a genuine interest in human-robot interaction research, and be willing to merge an analytical approach to control with experimental activities to test their algorithms on exoskeletons with humans in the loop. Programming skills (C/C++, Matlab/Simulink) are fundamental to successfully achieving the objectives.
Objectives: Control algorithms for exo-based assistance can highly benefit from an accurate and updated identification of human parameters and behavior. The objective of this DC is to devise and test new online calibration/identification methods for human-robot systems and a model predictive controller that accounts for the user's physical characteristics and behavior to provide user-centered, personalized assistance.

AERIALIST project abstract and key project information

In an era marked by groundbreaking innovations within assistive health technologies, people with motor disabilities have the prospect of achieving better health out- comes, enhanced treatment, improved quality of life, and increased participation in daily activities. This new way of healthcare has far-reaching implications, touching the lives of a diverse spectrum of individuals, from the expanding elderly population, two out of three requiring at least one assistive product to patients and healthy individuals navigating the challenges of automated work environments. Noteworthy examples include deploying rehabilitation robotics for home-based treatment, electric wheelchairs facilitating independent mobility, telehealth applications for cardiovascular monitoring, and powered prostheses restoring mobility and confidence in various daily life activities.

Current Landscape: The Promises and Limitations

While recent advances in hardware, sensing, and actua- tion technologies for assistive health technology showcase the immense potential for pervasive improvements in health and quality of life, significant hurdles remain. Cutting-edge systems face challenges when thrust into the uncertainties of real-world domestic environments, lacking adaptability and being burdened by the need for manual adjustments. Moreover, task-specific finetuning, safety, and reliability are not guaranteed in changing environments, and unforeseen circumstances can pose additional challenges. Good assistance is usually limited to supervised clinical settings, remaining far from the reach of individuals. The consequence is suboptimal assistance that is barely sufficient for most standard use-cases, at best, often leading to misuse or even the non-use of the assistive devices.

Urgent Call for Progress: Facing Reality

Statistical investigations in the UK and across Europe, show a surge in hospital admissions for acquired injuries and a concerning prevalence of amputations. This emphasises the critical need for advances in prosthetic technology and assistive healthcare.

For example, **wheelchair** users face a significant challenge, with 87% reporting frequent falls that often result in traumatic brain injuries, highlighting difficulties to adapt to daily-life changes and challenging environments. This struggle within assistive technologies is emphasised by a rejection rate of 39%, 53%, and 50% for myoelectric hands, passive hands, and body-powered hooks among prosthetics users, mainly due to their limited functionalities and a lack of sensory feedback.

Consequently, individuals using these prosthetics experience severe functional disabilities, hindering their daily activities. Moreover, major risk factors such as diabetes and peripheral artery disease, make these problems even harder to solve. For instance, Austria reported 11.4 major lower-extremity amputations per 100,000 population with diabetes in 2019. **Monitoring health** through biosignals analysis and appropriate feedback can be crucial in addressing these issues.

Addressing the major challenges that lead to today's suboptimal assistance is vital to enhance the well-being and functionality of individuals with mobility and health-related concerns. Specifically, progress is crucial in health monitoring, ambient intelligent interaction, and regaining motor function.

AERIALIST's Mission: Bridging the Gap

In response, AERIALIST takes on the challenge of advancing assistive health technologies to provide adaptive, reliable, and intelligent solutions. Our mission is to create systems that seamlessly adapt to users, environments, and tasks, offering human-like, intuitive, and symbiotic assistance. To achieve this, our research leverages the vast potential of recent theoretical machine-learning developments, translating them into real-world physical interactions between humans and engineering systems.

The 'Doctoral Network on Assistive Health Technology in Unsupervised/Home Settings' (**AERIALIST**) will involve a team of 15 Doctoral Candidates (DCs). On top of the regular 12 positions funded by the European Commission, there will be 2 additional positions funded from Switzerland. Each DC will engage in individual research projects designed to advance assistive health technology, enabling users to push the boundaries of human potential by enhancing adaptability, safety, and embracing multidisciplinary approaches. The project addresses **four specific challenges** that these 15 DCs will tackle collectively. Given the interdisciplinary nature of the tasks related to sensing / intelligent perception and control (WP2), symbiotic interaction (WP3) and all with a focus on 'learning' (that is in all topics a factor) and safely (WP1) and applying (WP4), the project requires an interdisciplinary team. Aiming for the best available talent, the network will be guided by renowned experts from Europe, including industry leader such as OBHP (AT), as well as in small and medium-sized enterprises (SMEs) like TYRO (AT), WR (IT), RSM (CH), Medisanté(CH) and PLUX (PT) and spin-offs, such as SensorStim (DE), industry- oriented research centres like FHG IESE (DE), Johner Institu (DE), FHG IEM (DE) and CSIC (ES), and medical-focused research centres such as BAL (CH), EMC (NL) and FUHNPAIIN (ES). These partners, in collaboration with leading European universities like KUL (BE), LUH (DE), TUD (NL), FCT NOVA (PT), SSSA (IT), RWTH (DE), POLIMI (IT), UZH (CH), and UNIBAS (CH), are integral to the project's success, see **Figure 1**.

The AERIALIST project aims to address several key challenges related to assistive health technology in unsupervised/home settings. These challenges include:

Challenge 1 – Enhancing Adaptability for Symbiotic Interaction: A primary challenge for the AERIALIST project is to improve the adaptability of assistive health technology while fostering symbiotic interaction. These systems should adjust seamlessly to users' evolving needs and establish a harmonious relationship with them. AERIALIST seeks to develop solutions that make these technologies more flexible, responsive, and capable of working in synergy with users, ensuring that they remain effective in real-world, unsupervised settings. This symbiotic interaction will enhance assistive devices' overall experience and effectiveness in home environments.

Challenge 2 – Ensuring Safety: Safety is paramount, particularly in home settings where unpredictability is inherent. AERIALIST focuses on developing technologies that prioritise user safety, reducing the risk of accidents or harm associated with assistive devices. This includes the prevention of accidents like falls and collisions.

Challenge 3 – Creating intelligent Perception and Learning: To create assistive devices that can adapt and assist users in a home environment, they must have the capability for intelligent perception and learning. AERIALIST seeks to advance the technology's ability to understand and interpret user needs and environmental factors, enabling more intuitive and responsive assistance.

Challenge 4 – Bridging multidisciplinary knowledge gaps: The project recognises that effective solutions demand a multidisciplinary approach. AERIALIST aims to bring together expertise from various fields, including engineering, AI, and medical. Collaborating across disciplines allows for a holistic approach to tackle the multifaceted challenges of enhancing assistive health technology.

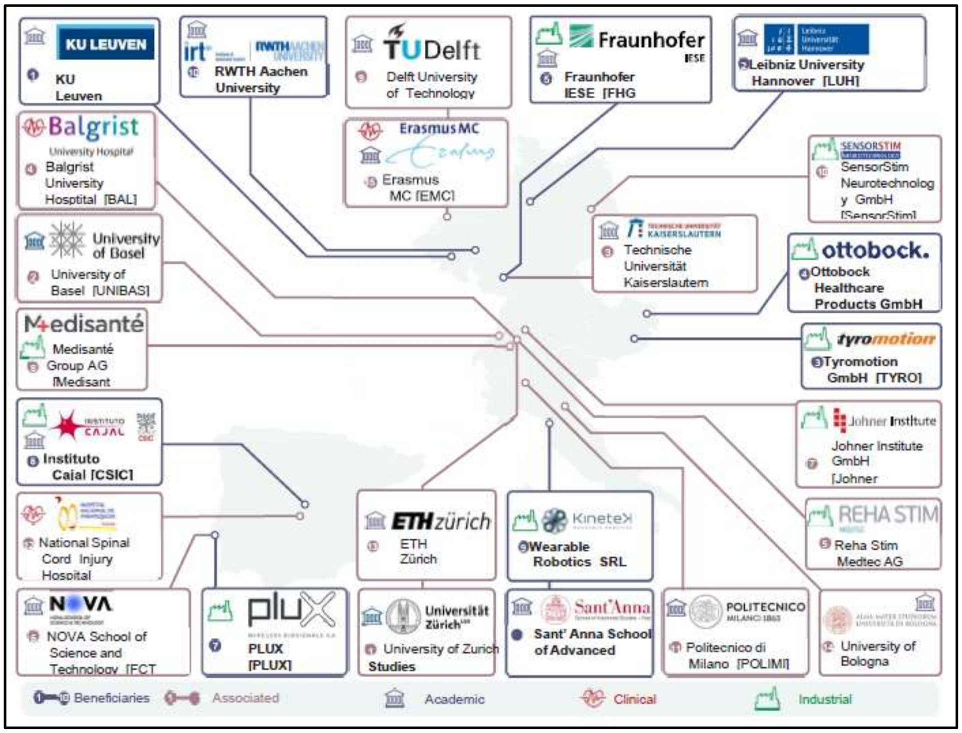


Figure 1: AERIALIST Consortium overview

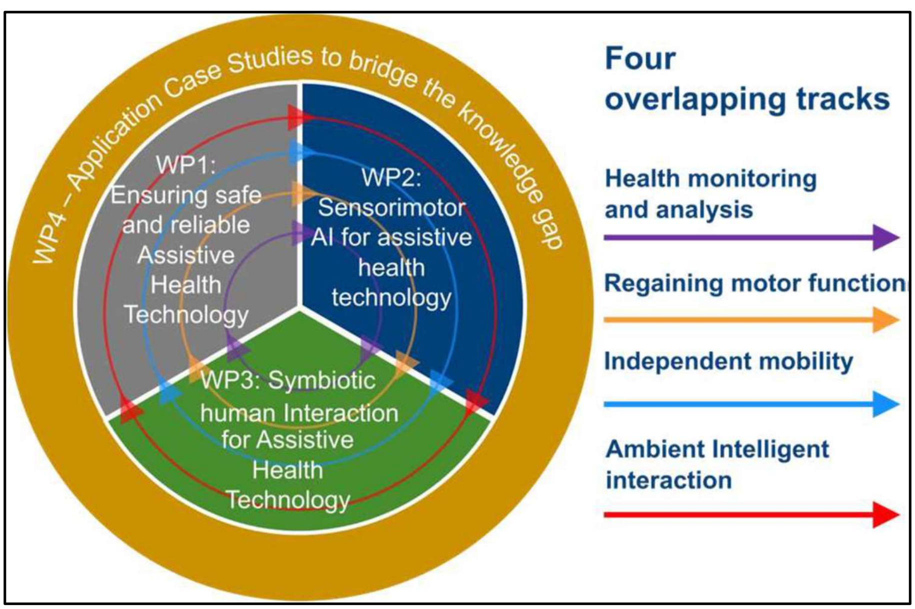


Figure 2: AERIALIST WP structure

The AERIALIST project comprises seven Work Packages (WPs). Of these, four are dedicated to Scientific and Technical (S&T) activities (**WP1–4, see Figure 2**), one focuses on training (WP5), another on Exploitation, Dissemination, and Communication (WP6), and the final WP is devoted to Management (WP7). Details of the activities in the 4 S&T WPs are described below.

WP1: Ensuring safe and reliable Assistive Health Technology

In WP1 a team of 3 DCs embarks on the essential task of integrating safety-aware design into the development of resilient Assistive Health Technology. **DC1** and **DC2** are dedicated to establishing generic frameworks and methodologies that inherently ensure safe behaviour during runtime, while **DC3** focuses on specific hardware and software/ML techniques and measures to achieve fault-tolerant, and fail-operational, behaviour.

DC1 pioneers the application of innovative hazard-and- risk-analysis methods, specifically STAMP 9 and STPA, to enhance the safety of symbiotic Assistive Health Technology. Collaborating with **DC8** (WP3), **DC15** (WP4), and **DC7** (WP2), **DC1** focuses on reshaping the user-interaction ecosystem. This involves developing human-centred executable safety cases and integrating insights from interpreting user intentions related to neurological movement disorders (**DC8**). The approach ensures safety in Electrical Stimulation with Wearable Robots (**DC7**) and user-centered model predictive control for robotic assistance (**DC15**), thereby mitigating safety risks in complex systems.

DC2 focuses on enhancing the runtime safety of ML-based controller in assisted-person scenarios through digital twin technology. It improves hazard detection by analysing deviations from established operations, ensuring effective real-time responses. Additionally, the frame-work advances the detection of hazardous situations, reinforcing safety measures and leveraging insights from the machine learning model. Collaborating with **DC5** (WP2), **DC9** (WP3), and **DC13** (WP4), **DC2** integrates its runtime safety case with tasks involving real-time multimodal data gathering (**DC5**, WP2), situation-aware controller selection for robot-assisted overground gait training (DC9, WP3), and in-game assessments in the field of rehabilitation robotics (DC13, WP4), contributing significantly to reinforce the runtime safety assurance for assistive technology.

DC3 focuses on leveraging compressed sensing and sensor fusion to generate precise and compact data for identifying malfunctions caused by electromagnetic interference (EMI). This contribution extends to real-time detection with limited resources in embedded systems, relying on indicators like bit error rates and control/data-flow error detection. Collaborating with **DC4** (WP2), **DC9** (WP3), and **DC12** (WP4), **DC3** integrates its EMI risk management during runtime case with tasks relate to probabilistic, data-driven sensor fusion (**DC4**,WP2), user-interaction awareness through situation-aware controller (**DC9**,WP3), and wearable sensors for health monitoring (**DC12**, WP4), contributing significantly to EMI detection in real-life conditions.

WP2: Sensorimotor AI for assistive health technology

WP2 aims to enhance assistive health technology's perceptual and decision-making aspects through artificial intelligence. Led by the expertise of **DC4** and **DC5**, it focuses on developing intelligent perception mechanisms to heighten situational awareness. The initiative includes formulating reinforcement learning implemented by **DC6**, while **DC7** focuses on biomimetic control strategies. These innovations collectively aim to make assistive technology more intuitive and responsive in unsupervised and home environments. The dedicated team within WP2, propels these advances.

DC4 pioneers data-driven sensor fusion for reliable human-Assistive Health Technology sensing in real-life conditions. Focusing on intricate questions regarding sensor configurations and complexities of real-world environments, **DC4** develops innovative probabilistic sensor-fusion algorithms. These algorithms yield precise motion estimations and uncertainty insights will be obtained using techniques derived from observability analysis. The goal is to create revolutionary motion-estimation algorithms seamlessly integrating model-driven sensor fusion and data-driven techniques **DC4's** work supports the advancements of EMI detection by **DC3** (WP1). Close collaborations with **DC3**, **DC11** (WP3), and **DC8** (WP3) ensure the integration of probabilistic sensor-fusion algorithms with EMI risk management, multi-agent learning, and intention sensing in neurological movement disorders, respectively. Validation, the medical-oriented research center EMC, will enhance sensor-fusion algorithms in real-life conditions.

DC5 takes on the challenge of developing an efficient, real-time, multimodal data-gathering architecture for wearable assistive Health Technology. Recognising the need for swift responses with near-zero latency, **DC5** focuses on distributed edge processing. This involves designing novel edge-based distributed computation algorithms for machine-learning-based event-triggered data processing. Leveraging local edge computing provides immediate feedback while reducing strain on the wireless network and enhancing privacy. Collaborating closely with DCs in WP2, DC5 forms synergistic partnerships with **DC10** (WP3)and **DC12** (WP4) in the health monitoring and analysis track, as well as with **DC9** (WP3) in the ambient intelligent interaction track.

This collaboration seamlessly integrates non-redundant real-time multimodal data gathering with tasks related to physics-based and probabilistic ML approaches for improved co-adaptation in power exoaid (**DC10**, WP3), wearable sensors for health monitoring and assistive communication (**DC12**, WP4), and situation-aware controller selection for robot-assisted overground gait training (**DC9**, WP3).

DC6 focuses on integrating iterative learning control and reinforcement learning techniques to identify motor primitives, aiming to enhance motor learning in Assistive Health Technology for increased versatility and reliability in real-life conditions. Collaborating closely with **DC11** (WP3) in the independent mobility track as well as with **DC1** (WP1) and **DC14** (WP4) in Ambient Intelligent interaction, **DC6** applies these control strategies in a rehabilitation context at OBHP. Together, they seamlessly integrate reinforcement learning for identifying motor primitives with tasks in-volving collective collaboration and knowledge exchange, with only individual user-specific characteristics (**DC11**, WP3), for application of system thinking and system safety to powered wheelchairs' head-foot steering system (**DC1**, WP1), and enhancement of prosthetic limb control, balancing adaptability and safety (**DC14**, WP4).

DC7 pioneers biomimetic control strategies by seamlessly integrating a user-centered model predictive control approach for robotic assistance (**DC15**, WP4) with sensing the intention to move in people with neurological movement disorders (**DC8**, WP3). This innovation aims to establish active bio-feedback, enhancing the natural interaction between individuals and wearable robotic systems. **DC7** investigates how neuromuscular stimulation (**NMS**) within the predictive control approach can complement mechanical assistance in wearable robotic systems, promoting harmonious synergy between passively actuated limbs and biofeedback-driven user-initiated movements.

WP3: Symbiotic human Interaction for Assistive Health Technology

WP3 is all about enhancing human interaction with Assistive Health Technology. We want these interactions to mimic how humans naturally learn from their surroundings and adapt. Both the control strategies and the users need to be flexible and motivated to work together effectively. The goal is to create a smooth and intuitive partnership between humans and assistive health technologies. To make this happen, four DCs will study the interactions needed for the success of assistive technology. They will encourage collaboration between biological and artificial nervous systems, improve user awareness, and enable the sharing of user-robot interactions in different wearable robotic systems. This will lead to truly symbiotic interactions, especially in challenging everyday tasks.

DC8 focuses on enhancing Assistive Health Technology by detecting the movement intentions of individuals with neurological movement disorders, aligned with **DC1's** (WP1) safety objectives. Utilising advanced vision systems, **DC8** aims to create a wearable-sensor system for real-time kinematic estimations in diverse settings. Collaboration with **DC1** (WP1) ensures seamless integration of movement intentions into the technology's safety assurance, reducing the risk of unintentional actions. Rigorous algorithm refinement and validation, in partnership with the medical-oriented research center BAL, will enhance assisted gait analysis.

DC9 will explore enhancing user-interaction awareness through situation-aware controller selection for robot-assisted overground gait training. This investigation aims to switch between decision-making schemes intelligently, replacing conventional manual tuning methods and threshold-based controller switching. The goal is to provide swift and effective wearable robotic assistance for a wide range of movements. To validate the safety and efficacy of these controller-switching techniques, **DC9** will conduct testing using the FLOAT system at RSM. This testing will involve switching between various control algorithms developed by **DC6** (WP2), **DC7** (WP2), **DC10** (WP3) and **DC15** (WP4) during over-ground gait training.

The primary objective of **DC10** is to pioneer a hybrid approach that merges physics-based modelling with data-driven machine learning techniques, specifically focusing on co-adaptation for motion control of exo-aid. Exo-aid are external devices that aid individuals in performing tasks that they might otherwise find difficult due to physical limitations or disabilities. This research addresses a critical challenge – the effective control of human motion using exo-aid, mainly when the user introduces additional, unknown inputs alongside the control actions. These supplementary inputs are complex to integrate into a model that relies solely on physics-based principles. **DC10** utilises data-driven probabilistic machine learning techniques, refining and validating models with real-life data at TYRO. Collaborating closely with **DC6** (WP2), and **DC13** (WP4), this aligns well with Physics-Based and Probabilistic Machine Learning Approaches for Improved co-adaptation in exo-aid (**DC10**) and the use of rehabilitation robots (**DC13**, WP4).

DC11's key challenge is managing personalised interactions between Assistive Health Technology and users. The goal is to identify consistent elements across users, scenarios, and technologies, continuously discovering commonalities to enhance the technology's knowledge base. **DC11** explores collaborative learning, where shared data and experiences among a networked community of wearable devices contribute to collective knowledge. Collaborating with DC2 (WP1) focuses on enhancing digital twin accuracy, while collaboration with DC5 (WP2) ensures relevant data for secure wireless network sharing, facilitating co-adaptation within the AERIALIST program.

WP4: Application Case Studies to bridge the knowledge gap

All DCs collaborate across four tracks: *(i) health monitoring and analysis, (ii) regaining motor function, (iii) independent mobility, and (iv) ambient intelligent interaction* as shown in **Figure 2**. Their collective efforts ensure the comprehensive development and sustained effectiveness of Symbiotic Assistive Health Technology throughout its lifecycle. Collaborative data exchange enables holistic evaluation, addressing safety, functionality, and symbiotic solutions. WP4, the final deliverable, acts as a pilot, integrating outcomes from WPs 1-3. Four DCs lead case studies covering the design cycle, offering practical feedback and benefiting from where researchers engage in a two-way exchange, enriching the collective understanding.

DC12 focuses on developing and evaluating wearable sensors that utilise biosignals for assistive communication and health monitoring. By exploring various biosignals, including EMG, Electrooculography, mandibular movement, accelerometer-based data, and EEG signals, the research aims to enhance autonomy and disease management for individuals with mobility limitations. Collaboration with **DC8** (WP3) ensures relevant data and valuable insights into the progression of degenerative diseases within the AERIALIST programme. These biosignals enable control over devices, from mobile phones to wheelchairs and IoT- enabled environments. The innovative approach redefines interactions for individuals with mobility limitations, providing greater autonomy and health monitoring possibilities through additional biosignals like ECG or BVP.

DC13 also collaborates with **DC2** (WP1) within the AERIALIST program, specifically focusing on leveraging gaming technology for in-game assessments in the field of Rehabilitation Robotics. The collaboration aims to integrate insights from **DC2's** (WP1) work on digital twin technology in assisted-person scenarios, enhancing the accuracy of human-Assistive Health Technology models. By combining efforts, **DC13** and **DC2** (WP1) contribute to developing effective and engaging therapeutic experiences, blending rehabilitation practices with innovative technologies. Their collaboration addresses challenges related to user-centered design, ethical considerations, and personalised approaches. Together with **DC10**, they explore to minimise the interaction forces between the rehabilitation and the user, while integrated with the gaming technology for rehabilitation practices. The collaboration extends to addressing issues related to reliability, trustworthiness, cost-effectiveness, and the promotion of positive neuroplasticity.

DC14 aims to advance prosthetic limb technology by leveraging AI and computational technologies. The current challenges faced by individuals with lower-limb amputations, such as limited adaptability to unforeseen situations, necessitate intelligent control methods. While previous research has shown promising results in adaptability, translating these innovations into commercially viable products poses safety and reliability concerns. Collaborating with **DC1** (WP1) and **DC11** (WP3), **DC14** focuses on developing control approaches that enable users to safely and reliably control their prosthetic devices in unsupervised home settings. The goal is to enhance the interaction between individuals and their prosthetic devices through flexible and dynamically adaptive control methods.

DC15 is committed to developing user-centered control approaches for wearable robotic systems, focusing on highly precise Model Predictive Control (MPC) models. These models leverage personalised human data to achieve robust and customised torque control, optimising support for human movement. **DC15** also contributes to an online identification method for assistive-robot interaction, incorporating visual biofeedback to guide users. The goal is to maximise transparency for the wearer, considering factors like joint limitations, dynamic balance, and task-specific indices (e.g. level of assistance in rehabilitation or muscular effort in load carrying). Collaborating with **DC7** (WP2), **DC9** (WP3) and **DC2** (WP1) in the Independent mobility track, **DC15** integrates precision MPC into various tasks, including situation-aware controller selection, runtime safety assurance, and active biofeedback for a natural interaction between individuals and wearable robotics

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Appendix 1: Recruitment Procedure and Principles

Advertisement Process: The search for appropriate candidates will start as soon as the project is approved and is initiated through job ads published on ec.europa.eu/euraxess, Die Zeit/academics.de, LinkedIn and through personal contacts of the network partners. A preliminary AERIALIST recruitment web page will be put on-line as soon as possible (September 2024). This speedy timing is chosen in order to be able to attract the best possible students, who by and large graduate in May-June. Postponing the the start of the search for candidates to September 2024 would mean that the best students have already found PhD positions in academia or jobs in industry. A special effort will be made to promote the vacancies at Central and Eastern European universities (e.g., KU Leuven's Central Europe Leuven Strategic Alliance – CELSA)).

All the recruitment is in line with the European Charter for Researchers, providing the overarching framework for the roles, responsibilities of both the researchers and employers. The Code of Conduct for the Recruitment of Researchers functions as a set of principles and ensures that the selection procedures are transparent and fair. The recruitment strategy for AERIALIST will fully comply with the Code of Conduct's definition of merit. For example, merit is not just measured on researchers' grades, but on a range of evaluation criteria, such as teamwork, interdisciplinary knowledge, soft-skills and awareness of the policy and economic impact of science. The Recruitment Committee has members of each gender and considers the promotion of equal opportunities and gender balance as part of the recruitment strategy. Special efforts are made to attract women and researchers from new EU Member States. AERIALIST is targeting at least 5 female DCs.

Selection Process: The pre and final selection will be made in a collective progress, led by the *Recruitment Committee (RC)*, which consists of all the people who will be involved in the supervision process. Every member of the RC will receive 4 hours of training on recruitment procedures and will be made aware of factors like unconscious gender bias. The candidates can apply for a maximum of three projects and list their order of preference. The 30 most suitable candidate DCs are invited to a **Recruitment Event** (Bruges, Belgium, month 2). Each candidate gives a presentation and is interviewed. The committee selects the DCs (1) based on their scientific background and potential, (2) based on the expected benefit of the scientific exchange between the trainees' home countries and institutions and the hosts, and (3) in accordance with gender equality and minority rights. The candidates are ranked, and a collective decision is made, considering the order of preference. In this way a complementary team of DCs can be assembled. All non-selected candidates will receive a letter explaining the reasons why they were not selected (in line with the Code of Conduct). The DCs are employed on fixed-term contracts and are registered as staff candidates for their PhD degrees. Therefore, they are entitled to pension contributions, paid holidays, and other employment benefits, as governed by the universities, non-academic partners, and industrial companies.

Recruitment Committee (RC) = This committee involves the General Coordinator, the Vice-Coordinator and at least one representative per Beneficiary. Its goal is to oversee the recruitment of the 15 DCs during the collective recruitment event.

Gender considerations. The advertised positions will not contain gender-coded language and will describe the project, necessary qualifications, working conditions, entitlements, career development, timings and an overview of the selection procedure for maximum transparency. Where regulations allow, adverts will encourage female candidates.

In case not all 15 DCs can be recruited during the collective **Recruitment Event**, the recruitment procedure is "decentralised", meaning that the involved supervisors continue the search for good candidates. The GC is kept informed at all times when new eligible candidates appear. The GC makes an official complaint in case the Code of Conduct for the Recruitment of Researchers is breached. The involved supervisor is then expected to find another candidate. Recruitment problems are also, if still needed, discussed during additional RC meetings in order to deliver specific action plans to target specific networks relevant for the vacant DC positions. All details concerning the recruitment-procedure principles are communicated on the on-line application portal, so that potential DCs know exactly what to expect and are stimulated to apply.