Research topics

"End-to-End Vulnerability framework for Secure Software Systems" prof. Barbara Russo

This research project in cybersecurity aims to develop an end-to-end framework for the identification, validation, and mitigation of software vulnerabilities. The work will integrate advanced static and dynamic code analysis techniques to systematically detect insecure coding patterns, memory safety violations, and injection flaws in complex software systems. Detected vulnerabilities will be experimentally validated within a controlled cyber range environment, where their real-world exploitability and impact on confidentiality, integrity, and availability will be rigorously assessed. By bridging automated vulnerability detection with practical exploitation and impact evaluation, the project seeks to advance methodological rigor in application security research. The ultimate goal is to contribute novel techniques and tools that enhance secure software engineering and vulnerability assessment practices.

"3D Curve Geometry and Minimum-Jerk Timing for Human-Like Motor Control and Planning in Biomechanical Systems" prof. Marco Frego

Human arm and hand movements are remarkably smooth, a property often modelled using minimum-jerk principles, whereas engineered motion planners frequently rely on geometric path primitives that guarantee curvature continuity and feasibility. This PhD project aims to unify these perspectives by coupling 3D curves, defined by curvature and torsion, with optimal timing laws obtained by minimizing jerk under biomechanically meaningful boundary conditions. Methodologically, the work will derive and solve boundary-value and optimal-control formulations for time-parameterizing trajectories with prescribed endpoint speed and acceleration (including rest-to-rest reaches) and fixed movement duration. It will also address submovement segmentation and relate the resulting solutions to kinematics measured via motion capture. Prof. A. Peer's Human-Centered Technologies and Machine Intelligence Lab (HCT Lab) provide cutting-edge technologies for motion capture and the acquisition of physiological and muscular signals, as well as robotic arm manipulators. These resources enable the project to extend beyond purely kinematic modeling toward dynamics-informed analysis and validation.Expected outcomes include new curve-based motion primitives for human–robot interaction, quantitative links between curvature/torsion profiles and movement smoothness, and planning algorithms that improve safety, comfort, and energy efficiency in human-centered cyber-physical systems.

"Human-Centric Adaptive Manufacturing Systems for the Inclusion of Vulnerable Workers" dr. Luca Gualtieri

Despite strong societal efforts aimed at reducing physical, mental, intellectual, and sensory impairments, people with disabilities continue to experience daily discrimination and limited accessibility in both physical and digital environments. These barriers hinder their full participation in society. Within the Industry 5.0 context, this PhD project proposes the development of human-centric methodologies to enhance the inclusion of disabled and/or neurodivergent workers in industrial processes. The research includes the study of solutions based on lean, flexible, and reconfigurable production systems to support their effective integration and application in high-potential contexts where such systems remain underutilized, such as social cooperatives and Work Integration Social Enterprises (WISEs). Furthermore, the integration and further development of adaptive cognitive and/or physical assistance systems

will be investigated to improve inclusion, autonomy, satisfaction, and well-being among disabled and/or neurodivergent workers. The project aims to explore how manufacturing systems can be redesigned, implemented, and adapted to reduce performance gaps between workers with and without disabilities, thereby enhancing well-being, autonomy, and job satisfaction while simultaneously improving business performance, including the ability to manage complex orders, as well as quality and productivity. A key aspect of the research will involve analysing the specific requirements of social cooperatives and WISEs to support their effective and simplified future adoption of the proposed solutions.

"Dynamics, optimization and control of robots with flexible modules" prof. Andrea Giusti

The classical assumption of rigid bodies, ideal transmissions, and fixed kinematic structures in robotics forms the basis of most fundamental results in robot kinematics, dynamics, and control. However, modern robot design increasingly adopts lightweight structures, transmission elements with inherent flexibility, modular architectures, and soft components to improve adaptability, efficiency, and compliance. Novel modelling, optimization, and control methods for robots with flexible modules are becoming crucial to enable modern robotic systems to reach performance levels beyond those achievable with classical approaches.