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Engineering & Technology

Resilient Networked Autonomous Sytems for Cyber-Physical Scenarios

Description

The rapid evolution of mobile networks is enabling a new generation of human-centric cyber-physical autonomous systems integrated with advanced mobile connectivity. By leveraging ultra-low latency, massive bandwidth, edge and cloud computing, and reliable network infrastructures, these systems support real-time, wide-area human–machine collaboration and remote operations. The research has strong relevance for dual-use technologies, as capabilities such as secure remote command, telepresence, autonomous swarms, and resilient cyber-physical systems (CPS) can support both defense operations and civilian sectors including emergency response, smart infrastructure, industrial automation, and advanced training platforms. Key research directions include multi-robot and swarm systems, coordinated through mobile networks, including human–swarm interaction, distributed control algorithms, and ultra-reliable communications to enable real-time control and massive connectivity, situational awareness systems that combine mobile sensor networks, distributed analytics, and immersive visualization through sensor fusion, collaborative immersive telepresence that enables shared virtual environments where geographically distributed autonomous vehicles provide real-time information, and resilient CPS for mission-critical and military operations, focusing on robust operation in hostile or degraded environments, with autonomous network reconfiguration and fault-tolerant distributed control even under network disruptions. Such complex scenarios introduce a new frontier of complex vulnerabilities. At this particular respect, other relevant directions are agentic threats and protection from adversarial machine learning, quantum-safe scalable networks, cyber-physical resilience by dynamic security, and fail-safe protocols.

Infrastructures

UVIGO has launched a cutting-edge, 7-million-euro, 5G/6G experimental network on the Lagoas-Marcosende campus as a premier, flexible testbed for validating advanced 6G, sub-terahertz (THz) communications, and Artificial Intelligence (AI) technologies in real-world scenarios. It is a unique, high-capacity European testbed, featuring extensive radio base stations, edge computing equipment, and optical communication systems designed to enable 6G research. This network provides an ideal environment for developing and testing human-centric autonomous systems. Its combination of ultra-low-latency connectivity, massive bandwidth, and edge computing resources directly supports real-time human-system collaboration and the complex immersive applications they will support. High-end edge computing support for 20 base stations across multiple locations will complement distributed onboard computing. The successful candidate will also have access to RETECH 5G/6G Cybersecurity Laboratory (https://iclab.uvigo.gal/retech/), an initiative supported (NextGeneration EU and INCIBE, with MEC deployments, dedicated C-V2X emulation and measurement equipment for smart transportation scenarios. Furthermore, the lab is equipped with an OT cybersecurity layer, Deep Packet Inspection (DPI) firewalls, and specific hardware encryption devices for the practical integration of QKD and Post-Quantum Cryptography into conventional 5G/6G communications.

Keywords

Agentic AI Threats | Collaborative Immersive Telepresence | Cyber-Physical Network Resilience |Cyber-Physical Systems (CPS) | Dual-Use Autonomous Systems | Human-Swarm Interaction