Partner Letter for
Horizon Europe

HORIZON-CL3-2025-01-BM-01: Open topic on efficient border surveillance and maritime security

The **Control of Networked Systems** group at the **University of Klagenfurt** seeks to join consortia in Horizon Europe, HORIZON-CL3-2025-01-BM-01; providing the following call relevant expertise:

Our Expertise
GNSS independent **modular sensor fusion**: Resilient **equivariant** methods (vision, radar, IR, lidar, UWB, etc)
Data alignment across different reference frames using real-time sensor fusion and state estimation
Self-aware and self-calibrating robotic systems able to re-calibrate and re-initialize online with **self-healing** capabilities
Heterogeneous multi-agent **collaborative state estimation** and sensor fusion onboard compute constraint platforms & **dynamic online autonomy** through behavior trees and knowledge graphs
Application oriented implementation on real platforms, large RAS test and **validation facilities** (1'300m^3 indoor, 15'000m^3 outdoor)

Description of organisation & research group

Since its foundation in 1970, the **University of Klagenfurt (UNI-KLU)** has become established on the national and international academic landscape. The QS World University Ranking 2023 shows that for the first time ever, University of Klagenfurt is among the top 500 universities and has been ranked among the best. The university comprises four faculties (Arts, Humanities & Education; Social Sciences; Technical Sciences; Management, Economics and Law). The following degree programmes are available: 20 bachelor's degree programmes, 29 master's degree programmes, 14 School Teacher's Training Certificates and 5 Doctoral degree programmes. Around 12,000 students from 100 countries are currently studying at the University of Klagenfurt. The university has **profound experience with EU projects** – 29 FP7 projects, among which two coordinated by UNI-KLU (including one notable ERC Grant award and one Marie Skłodowska Curie Individual Fellowship), 22 Horizon 2020 projects, among which five coordinated by UNI-KLU (including three notable ERC grant awards). In the past months, Grant Agreements for 5 Horizon Europe projects have been signed, two of which are coordinated by UNI-KLU, and another 2 Horizon Europe projects are in Grant Agreement preparation.

The **Control of Networked Systems Group (CNS)** is part of the Institute of Smart Systems Technologies and is engaged research activities cover control theory, state estimation and motion planning, modeling of dynamic systems, simulation, and (mobile) robot automation in multi-agent scenarios. We pursue these activities both from a classical and data-driven AI perspective. The field of interests include, but are not limited to, the following: Collaborative (mobile) robot autonomy in 3D space, state estimation aware control and motion planning, on-board environment perception and decision making, long-term task execution in changing environments, networked mission planning for multiple agents. The Control of Networked Systems Group seeks to push the current limits in AI supported state estimation, cooperative visual perception, and multi-modal sensor fusion for autonomous and networked systems.

Key Research Facilities, Infrastructure, and Equipment

There will be direct access to a 150m^2 drone hall to test drone and other (mobile) robotic related frameworks. The hall features a volume of more than 1300m^3 with a high-precision tracking system, a cable robot to emulate low-gravity environments, and high-performance computer units for AI training. From autumn 2025, an outdoor arena with 1000m^2 and 15000m^3 volume will be available with an identical tracking system.

Call Relevant Contributions: Extended Information

Programme	Horizon Europe
Reference of Call	HORIZON-CL3-2025-01-BM-01: Open topic on efficient border surveillance & maritime security
Offered role	Partner / Work Package leader / (Coordinator)

Offered contribution/expertise
Equivariant Multi-sensor fusion for resilient localization in challenging real environments: • Localize aerial, ground robots and persons, devices in real-time • Provide GNSS independent low-drifting localization for resilient operations • Include intermittent (GNSS) signals, for sporadic (global) updates • Automatically analyze signal health to drop/include sensor information • True modularity extending system with sensors during missions • 1st place for monocular methods in the FPV robust state estimation competition 2024 with drone speeds up to 100km/h • Self-calibrating framework intrinsics and extrinsics running on low compute power • Sensors: Radar, camera, lidar, UWB, multiple GNSS, magnetometer, pressure sensor, DVL, IMU • Fully consistent state estimation, fast convergence, large beacon of convergence
Collaborative state estimation across heterogeneous agents using isolated estimator concept: • Leverage different signals available to different agents for swarm resilience • Enable global swarm localization through information propagation from a single or few agents to the swarm • Geo-reference data and objects through swarm localization capability • Inherent alignment of data and reference frames from different agents • Time synchronization across the swarm • Merges seamlessly sensor fusion with collaborative state estimation using a sensor as an estimator regardless of its location • Highly scalable and adaptive with minimal communication requirements • Low computational complexity running online and on-board small vehicles • Tested and implemented on UAVs with relative UWB and pose measurements
Adaptive autonomy using knowledge-graph supported behavior trees: • Knowledge based mission adaptation upon unforeseen events • Simple/fast user interaction and mission/task definition via intuitive interfaces and (voice/gesture) commands • Highly portable mission structures across different RAS • Knowledge tree guarantees feasible mission constructions from e.g., LLM output • Diverse interfaces possible, e.g., voice commands over LLM or gesture recognition • Modularized mission and task primitives as behavior sub-trees • Connector interface quickly adapts general behavior trees to specific platform
AI based object recognition and object relative metric navigation: • Relative metric pose inference to semantic objects or persons • Combine triage assessment with navigational/spatial information for quick and combined decisions and actions • Intuitive mission execution and interaction: autonomously finding and transporting persons/objects to following persons of vehicles in the field • 3D attitude and 3D metric position inference real-time on edge devices (Jetson Orin) • Full sim-to-real pipeline tested in real environments • Adaptive to persons and different objects via short training in simulated environment • Aleatoric uncertainty inference for robust outlier rejection and confidence measure

Experience in EU funded projects

BugWright2 (Horizon2020): https://cordis.europa.eu/project/id/871260
Underwater hull cleaning is an important part of ship maintenance, which includes all techniques used to keep the part of the ship under the waterline in good condition. The EU-funded BugWright2 project will develop and demonstrate an adaptable autonomous robotic solution for servicing the outer hulls of ships. It will combine the survey capabilities of autonomous micro air vehicles (MAV) and small autonomous underwater vehicles (AUV).

CPSwarm (Horizon2020): https://cordis.europa.eu/project/id/731946
Cyber-Physical Systems (CPS) find applications in a number of large-scale, safety-critical domains e.g., transportation, smart cities, etc. While the increased CPS adoption has resulted in the maturation of solutions for CPS development, a single consistent science of system integration for CPS has not yet been consolidated. CPSwarm tackles this challenge by proposing a new science of system integration and tools to support engineering of CPSswarms

IoSense (Horizon2020): https://cordis.europa.eu/project/id/692480
Flexible FE/BE Sensor Pilot Line for the Internet of Everything
Aim of IoSense is to boost the European competitiveness of ECS industries by increasing the pilot production capacity and improving Time-to-Market for innovative microelectronics, accomplished by establishing three fully connected semiconductor pilot lines in Europe: two 200mm frontend (Dresden and Regensburg) and one backend (Regensburg) lines networking with existing manufacturing lines.

Contact details

Organisation	University of Klagenfurt (PIC: 999836813)
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