FRONTEX
RESEARCH
GRANTS
PROGRAMME

TÉCNICO LISBOA

Project BSENSED

Digital twin from multi-sensor data for enhanced border surveillance and situational awareness

Kick-off Meeting
Videoconference, 16 September 2025

Call 2024/CFP/INNOVATE/01
Novel Technologies for Futureproofing the EU External Borders (open theme)
Grant Agreement n. 2025/276

Beneficiary
Instituto Superior Técnico
University of Lisbon (Portugal)

Distribution Level
Sensitive

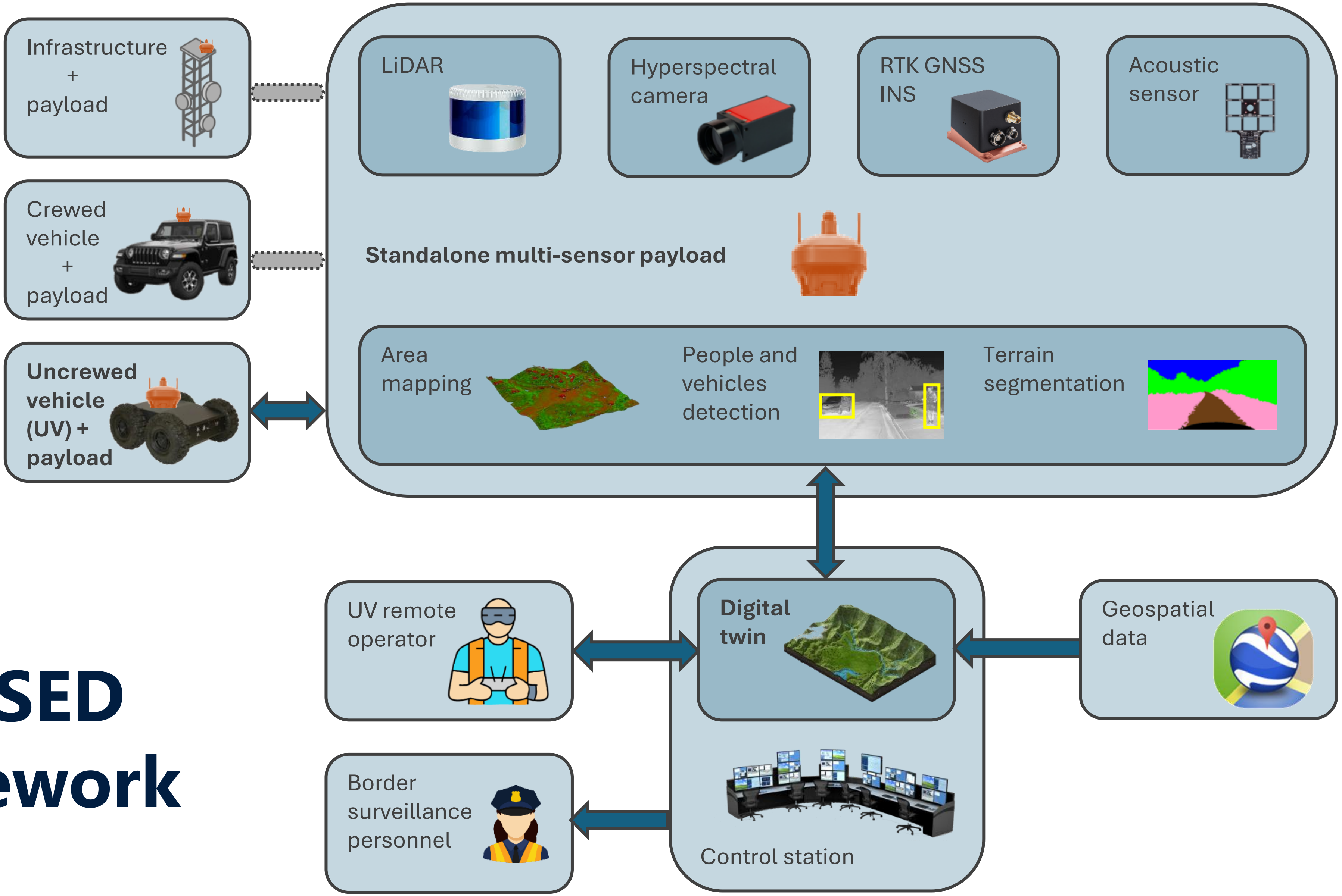
Challenges

- Border surveillance, either on infrastructures or on natural terrain, is a complex task.
- Surveillance systems can generate an overwhelming amount of data, sensitive to adverse weather conditions, making real-time situational awareness a cumbersome task for limited staff.
- Robotic platforms may assist in remote surveillance but require personnel training and trust in the equipment operation.

Scientific objectives

1. To create a digital twin of an outdoor area combining geospatial and multi-sensor data obtained from multi-platforms (stationary and/or movable).
2. To automate the fusion of multimodal data towards:
   i. efficient data analysis and visualization for enhanced situational awareness,
   ii. automatic area mapping and characterization,
   iii. automatic people and vehicle detection.
3. To enable an uncrewed ground vehicle (UGV) for safe remote operation during multi-sensor data acquisition on complex terrain.
4. To create a training simulator for UGV remote operators training based on the digital twin.

BSENSED framework



Gantt

WP Nr.	WP Name Task & Subtask descriptions	M1 Sep'25	M2 Oct'25	M3 Nov'25	M4 Dec'25	M5 Jan'26	M6 Feb'26	M7 Mar'26	M8 Apr'26	M9 May'26	M10 Jun'26	M11 Jul'26	M12 Aug'26
1	**Project Management and Dissemination**												
	Task 1.1: Financial, Administrative & Technical Management												
	Task 1.2: Dissemination												
2	**Use Case Definition and System Requirements**												
	Task 2.1: Scenario Analysis, System Requirements and Performance Metrics												
	Task 2.2: Hardware Architecture												
	Task 2.3: Software Architecture												
3	**Hardware Development**												
	Task 3.1: Standalone Multi-Sensor Payload Prototype												
	Task 3.2: UGV - Robotic Enabler for Complex Terrain												
4	**Software Development**												
	Task 4.1: Digital Twin - Geospatial and Multi-Sensor Data Integration												
	Task 4.2: Digital Twin - People and Vehicles Detection, Localization and Representation												
	Task 4.3: Digital Twin + Safe UGV Remote Operation: Terrain Segmentation and Traversability Map												
	Task 4.5: Safe UGV Remote Operation: UGV Obstacles Detection and Collision Avoidance and Enhanced Perception												
	Task 4.5: Training Simulator - Uncrewed Ground Vehicle and Multi-Sensors Modelling + Digital Twin Offline Version												
5	**Testing, Validation and Evaluation**												
	Task 5.1: Systems Integration and hardware validation and testing												
	Task 5.2: Digital Twin with Multi-Sensor Payload on Infrastructure and Crewed Vehicle - Validation and Evaluation												
	Task 5.3: Digital Twin with Multi-Sensor Payload on Robotic Enabler with Safe Remote Operation - Validation and Evaluation												
	Task 5.4: Training Simulator - Validation and Evaluation												

DELIVERABLES

Delivery Month	Name	Description
M1	Project website	Website of project with news and outcomes.
M12	Conference presentation	Presentation at international robotics conference.
M12	WP1 report	Draft of final financial, technical and scientific reports and of international journal paper.
M2	WP2 report	Summary of use case definition, system requirements and hardware and software architectures.
M5	WP3 report	Summary of integration of standalone multi-sensor payload and of UGV upgrade and respective resulting prototypes. Includes architectures and representative illustration of overall prototypes and respective functioning (images/videos).
M11	WP4 report	Summary of digital twin, training simulator and collision avoidance software developed, including architectures and representative illustration of execution (images/videos).
M12	WP5 report	Summary of systems testing, validation and evaluation, and lessons learned, with representative images/videos of systems performance in use case operational scenario.

Research team

Prof. Alexandra Moutinho
Principal Investigator / Researcher on cyber-physical systems, intelligent perception, multimodal data fusion and autonomous systems.

Prof. António Grilo
Researcher on communications and IoT.

Prof. Susana Vieira
Researcher on artificial intelligence, machine learning and digital twins.

Prof. Agostinho Fonseca
Researcher on systems integration, experimental testing and dynamic systems simulation.

Prof. João Fernandes
Researcher on electric powertrain and power management.

Prof. José Azinheira
Researcher on uncrewed vehicles autonomous navigation and computer vision.

Research infrastructures

Mobile Robotics Laboratory

Laboratory dedicated to mobile robotics developments, with equipment required for mechatronic systems development and integration.

Robotics Arena

A 12x4x4 m volume protected with nets and covered by motion capture system for ground and aerial drones testing and validation.

VIGILANT UGV

4-wheels lightweight uncrewed ground vehicle used in mobile robotics research.

Laboratory of Electrical Machines

The equipment available at this laboratory is suitable for the hardware electric development requirements of WP3, namely the UGV powertrain upgrade.

FRONTEX RESEARCH GRANTS PROGRAMME

The project leading to this presentation has received funding from Frontex under the Frontex Research Grants Programme.
Call for Proposals 2024/CFP/INNOVATE/01
Grant Agreement No. 2025/276.

FRONTEX
EUROPEAN BORDER AND COAST GUARD AGENCY