ROBOTS AI & US

Catalog

A scientific initiative led by the CAR

2026

1. Robots, AI and Us

Positioning

The Centre for Automation and Robotics (CAR)

The Centre for Automation and Robotics (CAR) is a joint research centre of the Spanish National Research Council (CSIC) and Universidad Politécnica de Madrid (UPM).

With more than 100 researchers, CAR develops robotic and AI-based systems designed to operate in complex, dynamic and safety-critical environments. The Centre combines scientific research with system-level engineering, delivering functional prototypes and validated technologies in real-world conditions.

This innitiative has been supported by the MaXCSIC Excellence Award (Ref. DEEP-MaX-2024_CAR)



Robots, AI and Us

Our project

Robotics and Artificial Intelligence are converging into a single technological paradigm where physical systems, intelligent decision-making and human interaction are tightly coupled.

«Robots, AI and Us» is CAR's scientific framework to address this transition.

It is built around a central question: how autonomous systems, artificial intelligence and humans can coexist, collaborate and adapt within shared environments in a safe, reliable and scalable way.

- How will Robots and Artificial Intelligence dwell among us and our daily lives?

- What scientific and technological challenges must be addressed for a seamless integration of robots into our daily lives in a sustainable economic, social, and ethical way?

The framework aligns robotics, control, perception, artificial intelligence and human–machine interaction under a unified perspective focused on real-world deployment. Rather than advancing individual technologies, it targets their combined behaviour in complex environments where uncertainty, physical interaction and human factors are intrinsic.

This approach addresses challenges that emerge only at system level: robustness in dynamic conditions, integration of human behaviour into control loops, scalability of AI-driven decision-making and the safety and trustworthiness of human–robot interaction.

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The objective is to enable autonomous systems that operate effectively beyond controlled settings, in domains such as mobility, healthcare, industry, agriculture and environmental monitoring.

Robots, AI and Us defines CAR's transition from fragmented research activities to an integrated effort aimed at developing the next generation of intelligent robotic ecosystems.

Anchored by its flagship infrastructure FUSE (Unified Shared Experimental Facility), CAR provides a unique real-world environment for integrated research in robotics, AI and human coexistence.

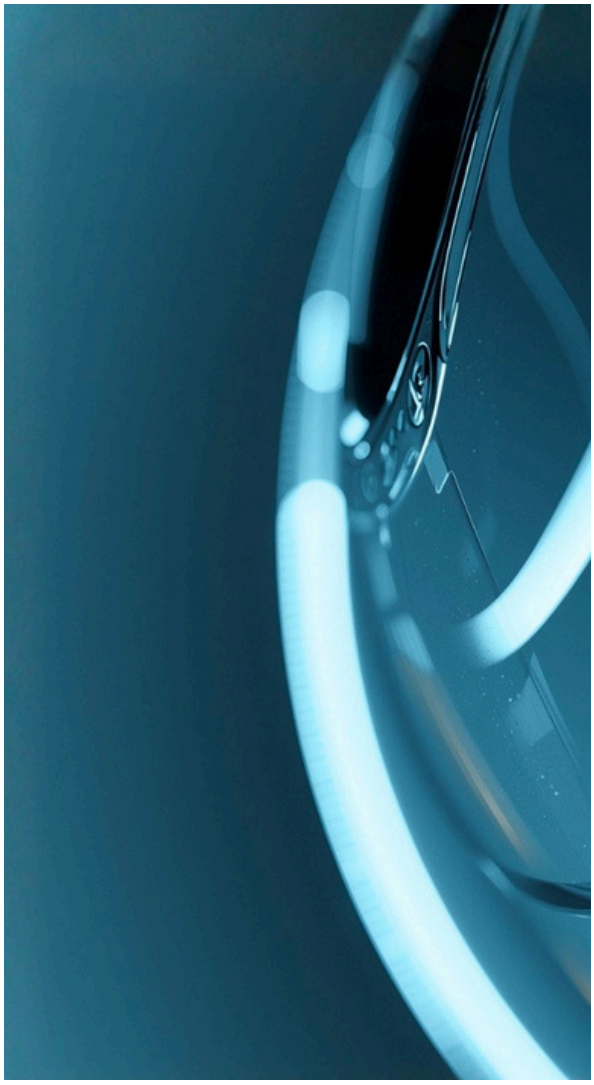


Engineering Autonomy for Real-World Impact

CAR focuses on enabling autonomous systems that operate under real constraints, where uncertainty, scale and human interaction define system performance.

The Centre advances perception-driven autonomy, cooperative robotic systems, intelligent control architectures and human–robot integration, with a strong emphasis on reliability, safety and deployment readiness.

Its developments are designed to increase operational efficiency, resilience and technological capability across strategic sectors.



Competitive Positioning

CAR operates at the intersection of research excellence and applied engineering, with a strong focus on system integration and real-world validation.

Likewise, this enables partners to address high-complexity technological challenges through rigorous engineering and deployable autonomy solutions.

CAR's activity is characterised by:

- *The integration of robotics, AI, perception and control at system level*
- *Proven capability in autonomous operation under real conditions*
- *Active participation in national and European collaborative projects*
- *Development of functional prototypes and experimental platforms*
- *Experience across multiple application domains*

2. CAR in Numbers

- € 4–5M annual budget in robotics and AI research and innovation
- 100+ researchers, including 46 Principal Investigators
- 50+ ongoing R&D projects, including 16 European projects
- 90+ European partners across collaborative initiatives
- Active collaborations with partners in Europe, USA, Japan, Korea and the UAE
- Strong portfolio of industrial contracts and application-driven projects

100+
investigators

46
staff

60+
PhD | PostDocs

21
technical and administrative staff

20
international projects

32
national projects

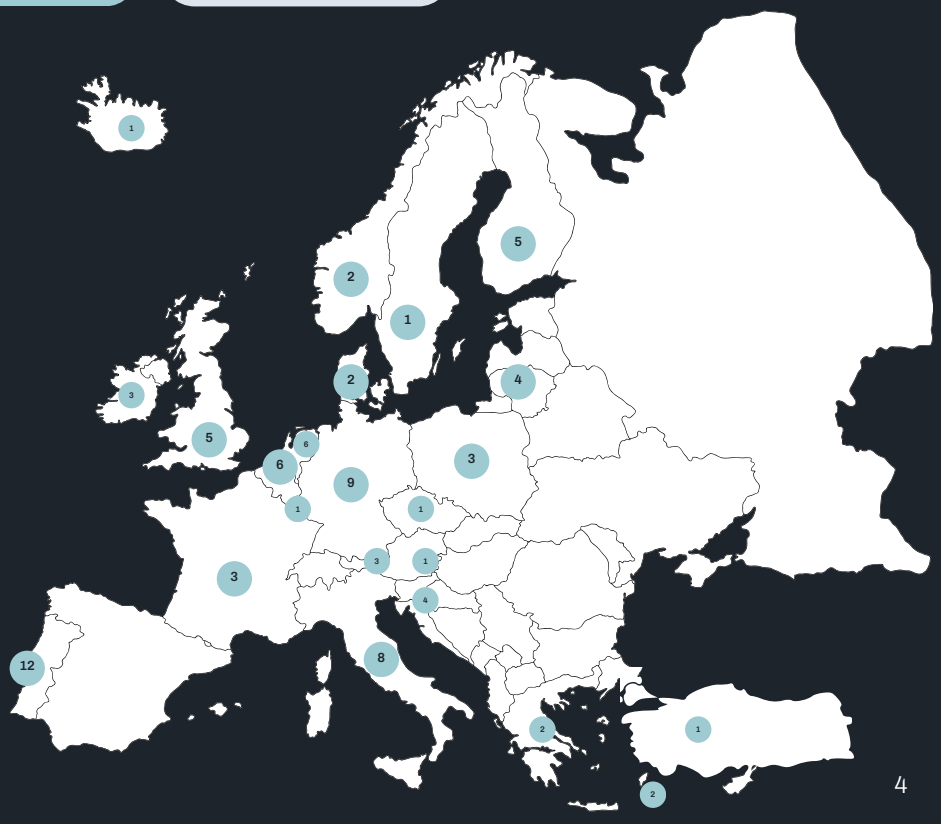
9
contracts with companies

4-5 millons €
budget / year

16
european projects

4
internacional projects

- Korea
- Emirats
- Japan
- USA.



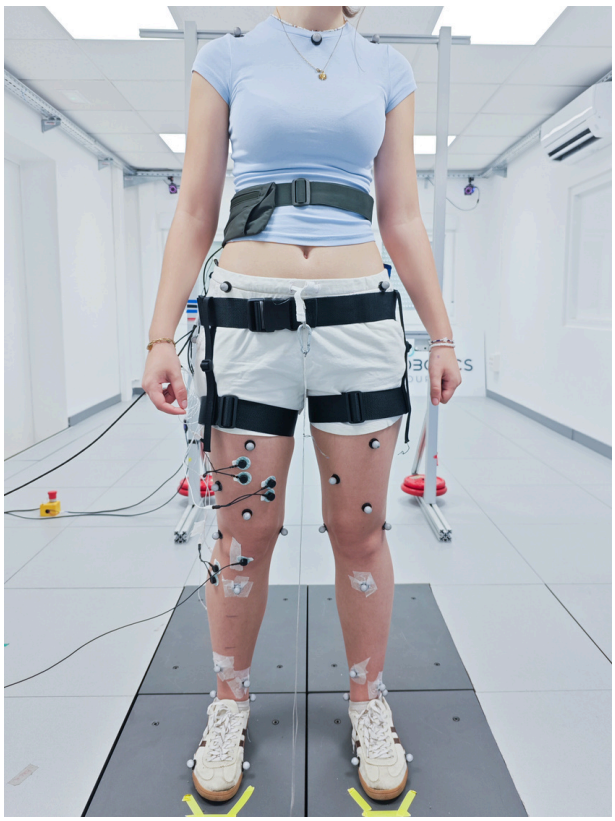
3. What We Do

(Research Tracks - RTs)

CAR designs, builds and validates integrated robotic and AI systems operating under real-world constraints.

Our work focuses on system-level execution, where perception, decision-making and control are combined into functional architectures and deployed in operational environments.

Such key innovations will be carried out following four **Research Tracks (RTs)** at the frontier of knowledge in various scientific and technological disciplines. Research Tracks are implemented by Research Units, that have been recently reorganised precisely to address this endeavour.



RT0. Ethics and Privacy

Intelligent Control and Cyber-Physical Systems

Strictly adhering to the **EU AI Act** to ensure reliable and certifiable autonomous solutions in real-world environments, CAR engineers control architectures for complex and interconnected systems.

By combining model-based approaches with artificial intelligence, the Centre develops adaptive and robust control strategies that improve system performance and reliability in industrial, energy and infrastructure contexts.

RT1. Human-Robot Interaction

Human–Robot Systems

CAR develops systems where human behaviour is part of the control loop.

This includes shared-control architectures, assistive robotics and human-aware systems that adapt to user intention, physical interaction and cognitive constraints. These technologies are applied in domains where safety, usability and interaction are critical.

RT2. Industry/manufacturing

System Architecture and Integration

CAR defines and implements system architectures that combine sensing, intelligence and control into coherent autonomous systems.

This includes the integration of heterogeneous components—robotic platforms, sensors, AI modules and control systems—ensuring reliable operation under constraints such as limited communication, environmental variability and system uncertainty.

RT3. Autonomous Systems

Autonomous Operation in Real Environments

CAR develops robotic systems capable of operating in dynamic, unstructured and large-scale environments.

These systems are designed to function beyond controlled settings, addressing challenges such as partial observability, changing conditions and multi-agent coordination. Validation is performed under realistic scenarios to ensure robustness and deployment readiness.

RT4. Field Robotics

Field Deployment and Validation

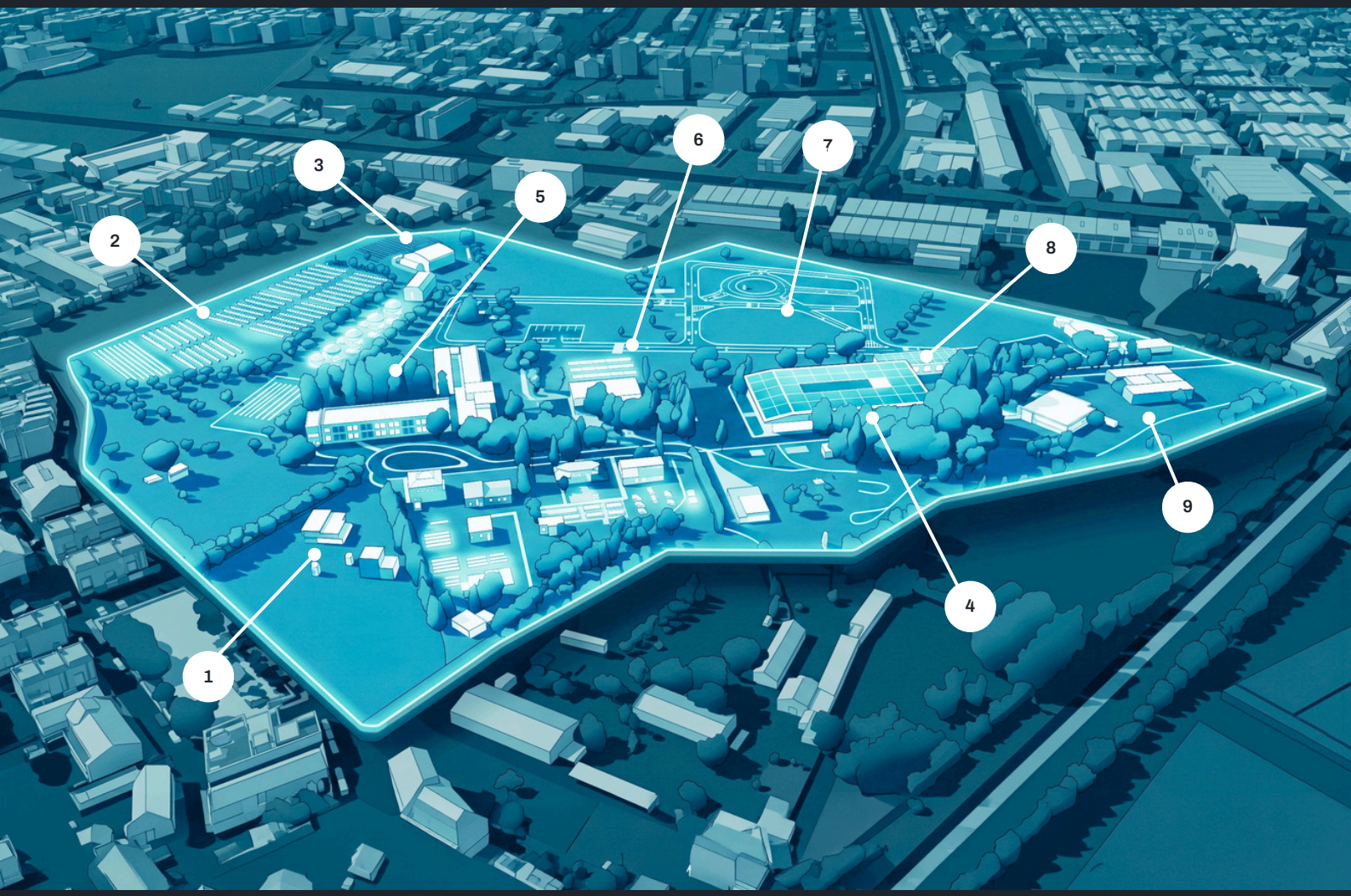
CAR validates technologies through experimental campaigns in both controlled and real-world environments.

This includes system-level testing, performance evaluation and iterative refinement under operational conditions. The objective is to reduce technological uncertainty and ensure that developments meet real deployment requirements.

Emerging Research Lines (2025–2027)

- **AI Embodiment** – robotic platforms for real-world AI testing and regulatory sandbox activities under the EU AI Act.
- **Space Robotics** – planetary exploration, in-situ resource utilisation (ISRU), in-orbit servicing, in collaboration with the Spanish Space Agency.
- **Defence Technology** – autonomous systems for security applications.

4. FUSE: A Living Lab for Robots, AI and Us



1. Experimental houses
2. Crop fields
3. Greenhouse
4. Office block (building A)
5. Office block (building B)
6. Experimental monorail
7. Driverless car circuit
8. Workshops
9. Warehouse

FUSE (Unified Shared Experimental Facility) is CAR's flagship experimental facility and the physical embodiment of its vision: *Robots, AI and Us*.

It is a large-scale, integrated environment designed to study how robotic and AI systems operate, interact and coexist with humans in real-world conditions.

A Real-World Experimental Ecosystem

FUSE is not a laboratory. It is a fully operational environment where heterogeneous systems are deployed and evaluated as part of everyday scenarios. This configuration enables the recreation of complex, cross-domain use cases where multiple technologies interact simultaneously. The facility includes:

- *AUTOPIA autonomous car circuit*
- *Experimental houses (multiple units)*
- *Greenhouse, crop fields and experimental vineyard*
- *Office blocks and warehouse*
- *CAR Robotics Arena*
- *Gait Analysis Lab*
- *Industry and Society 5.0 Lab*
- *Energy & Sustainability Lab*
- *Experimental monorail track*

From Isolated Systems to Integrated Scenarios

Traditional experimentation evaluates technologies in isolation. FUSE enables system-level validation, where robotics, AI and human interaction are tested as part of a shared environment.

This allows CAR to address challenges that only emerge at scale:

- *Multi-robot coordination in real conditions*
- *Human–robot coexistence and behavioural response*
- *Performance under environmental variability and uncertainty*
- *Integration of heterogeneous systems*

A Platform for Collaborative Research and Innovation

FUSE is designed as a shared environment for collaborative projects, enabling partners to develop and validate technologies in realistic scenarios. It positions CAR as a partner capable of bridging the gap between concept development and real-world deployment.

It supports:

- *Multi-partner experimentation within unified use cases*
- *Validation of technologies beyond laboratory conditions*
- *Demonstration of integrated solutions*

Progression towards higher Technology Readiness Levels (TRLs)



5. Infrastructure and Experimental Facilities

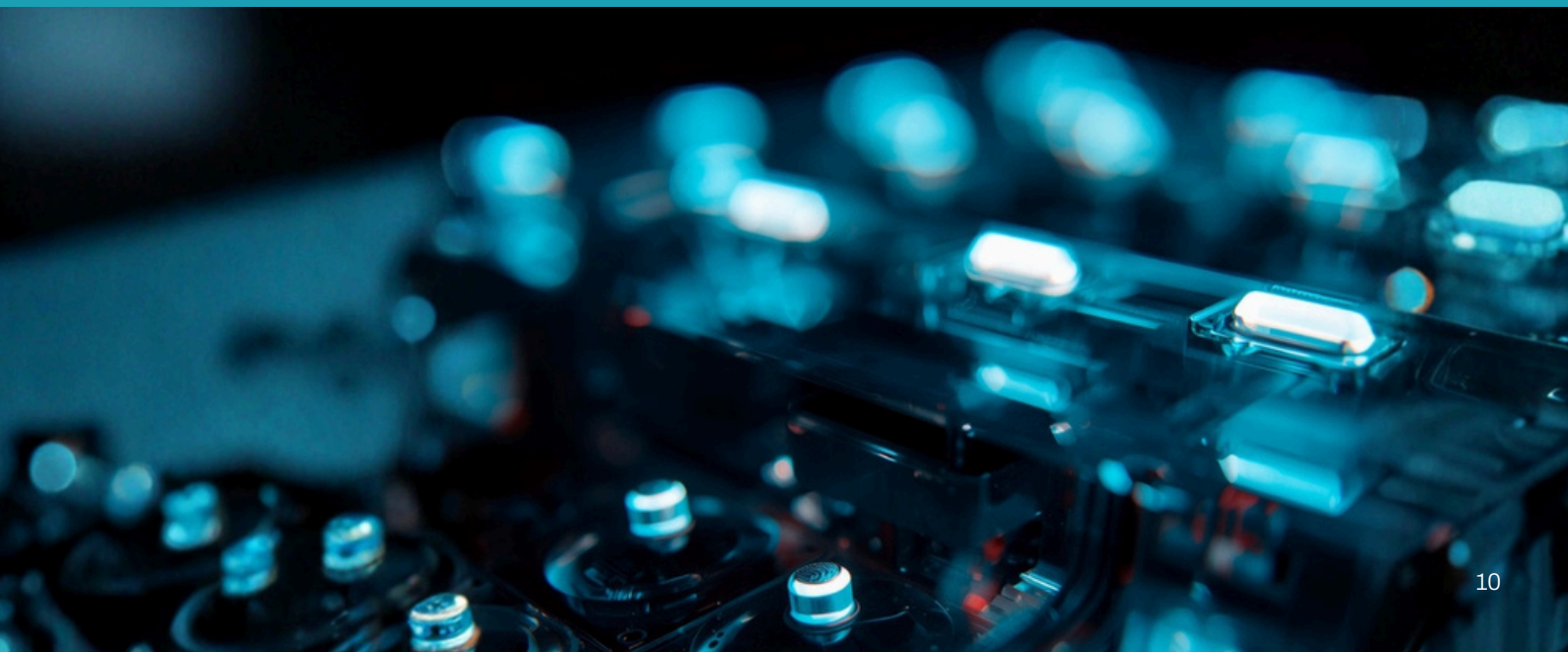
CAR supports the development and validation of autonomous systems through a combination of laboratory infrastructure and real-world experimental environments within the FUSE.

Our facilities enable the full cycle from controlled testing to field deployment, ensuring that technologies are validated under realistic operational conditions.

Robotic Platforms and Experimental Systems

CAR operates a diverse portfolio of robotic platforms, including ground and aerial systems, as well as wearable and human-interactive devices.

These platforms serve as testbeds for perception, control and AI algorithms, allowing rapid integration and validation of new technologies in representative scenarios.



Controlled Laboratory Environments

Dedicated laboratory spaces enable repeatable experimentation, precise measurement and early-stage validation under controlled conditions. These environments support the development and testing of:

- *Perception and localisation systems*
- *Control architectures and cyber-physical systems*
- *Human–robot interaction and neurotechnology*

Real-World Testing and Field Validation

CAR conducts experimental validation in outdoor and operational environments. This capability allows technologies to be tested under real constraints such as environmental variability, communication limitations and system uncertainty. This includes:

- *Industrial and infrastructure-related scenarios*
- *Large-scale robotic deployment contexts*
- *Agricultural and natural settings*



Human–Robot Interaction and Neurotechnology Labs

Specialised facilities support the development and evaluation of assistive robotics, wearable devices and human-centered systems.

These labs enable experimental studies involving human subjects, sensorimotor analysis and validation of shared-control strategies in realistic interaction scenarios.

System Integration and Prototyping

CAR integrates hardware and software components into functional prototypes, combining sensing, control, AI and communication systems.

This infrastructure supports rapid iteration, system-level validation and the transition from concept to demonstrator within collaborative projects.



6. Research Units

CAR's research is structured into specialised units that combine scientific depth with system-level integration, contributing to the development of autonomous systems in real-world environments.

1.- Human-Centered Systems



This unit focuses on the integration of robotics and artificial intelligence with human physical and cognitive processes.

It develops technologies that assist, augment and interact with humans, combining robotics, computational modelling and neuroscience. The unit addresses challenges in health, mobility and human–machine interaction, with a strong emphasis on adaptive systems capable of understanding and responding to human behaviour in real-world contexts.

Groups:

- Biorobotics
- Localization and Exploration for Intelligent Systems
- Intelligent Control
- Computational Modeling of Intelligence

2.- Supervision and Control

This unit focuses on enabling reliable interaction and coordination between humans, robots and complex machines.

Its work addresses how intelligent systems are monitored, controlled and adapted in real time, particularly in scenarios where human supervision remains critical. The unit develops advanced automation strategies, cooperative control frameworks and supervision architectures that ensure safe and efficient operation across industrial, semi-structured and unstructured environments.

Groups:

- **Advanced Automation of Machines, Processes, and Highly Complex Environments**
- **Intelligent Robots and Machines**



3.- Autonomy and Artificial Intelligence

This unit focuses on the development of decision-making architectures and intelligence for autonomous systems.

It advances methods that enable robots and unmanned platforms to perceive, decide and act in complex and uncertain environments. The unit combines fundamental research and applied development to create scalable, adaptive and secure autonomy solutions, addressing challenges in mobility, aerial systems and connected environments.

Groups:

- Autonomous Systems Lab
- Computer Vision and Aerial Robots
- Connected and Automated Driving



4.- Field Robotics

This unit focuses on autonomous robotic systems operating in large-scale, unstructured and dynamic environments.

Its research targets robots capable of executing complex missions under real conditions, including agriculture, environmental monitoring, infrastructure inspection and extreme environments. The unit develops systems that combine advanced sensing, locomotion and AI to achieve robust autonomy and effective coordination in challenging scenarios.

Groups:

- Field and Service Robotics
- Robotics and Cybernetics
- Artificial Perception Group
- Mechatronics and Advanced Design



7. Why Partner with CAR

CAR acts as a system integrator and technical partner in collaborative R&D projects, contributing both scientific expertise and engineering execution capacity.

• We Build and Integrate, Not Only Research

CAR does not operate at the level of isolated algorithms or theoretical developments.

We design, integrate and validate complete systems combining robotics, AI, perception and control.
We contribute where complexity increases: at system level.

• We Validate in Real Conditions

Through FUSE and our experimental infrastructure, CAR enables validation beyond controlled laboratory environments.

We test technologies under real constraints: uncertainty, scale, human interaction and environmental variability.
This reduces technological risk and strengthens project outcomes.

We Operate Across the Full Development Cycle

From concept definition to functional demonstration, CAR contributes across all project phases, which avoids fragmentation and accelerates progress towards higher TRLs.

- *System architecture design*
- *Technology development and integration*
- *Experimental validation and demonstration*

We Enable Multi-Partner Collaboration

We act as a connector between disciplines, systems and partners. CAR is structured to operate within complex consortia, contributing to:

- *Technical leadership of work packages*
- *Integration of heterogeneous technologies*
- *Alignment between research and application objectives*

• We Focus on Real Impact

Our work is driven by deployment-oriented challenges in domains such as mobility, agriculture, health, industry and sustainability.

We develop technologies intended to operate in real environments, with measurable impact on performance, efficiency and human interaction.

• A Strategic Partner for Robotics, AI and Real-World Systems

We enable partners to move from concept to reality in complex, high-impact technological developments. CAR provides a unique combination of:

- *Multidisciplinary expertise*
- *System integration capability*
- *Large-scale experimental validation (FUSE)*



8. Contact us

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