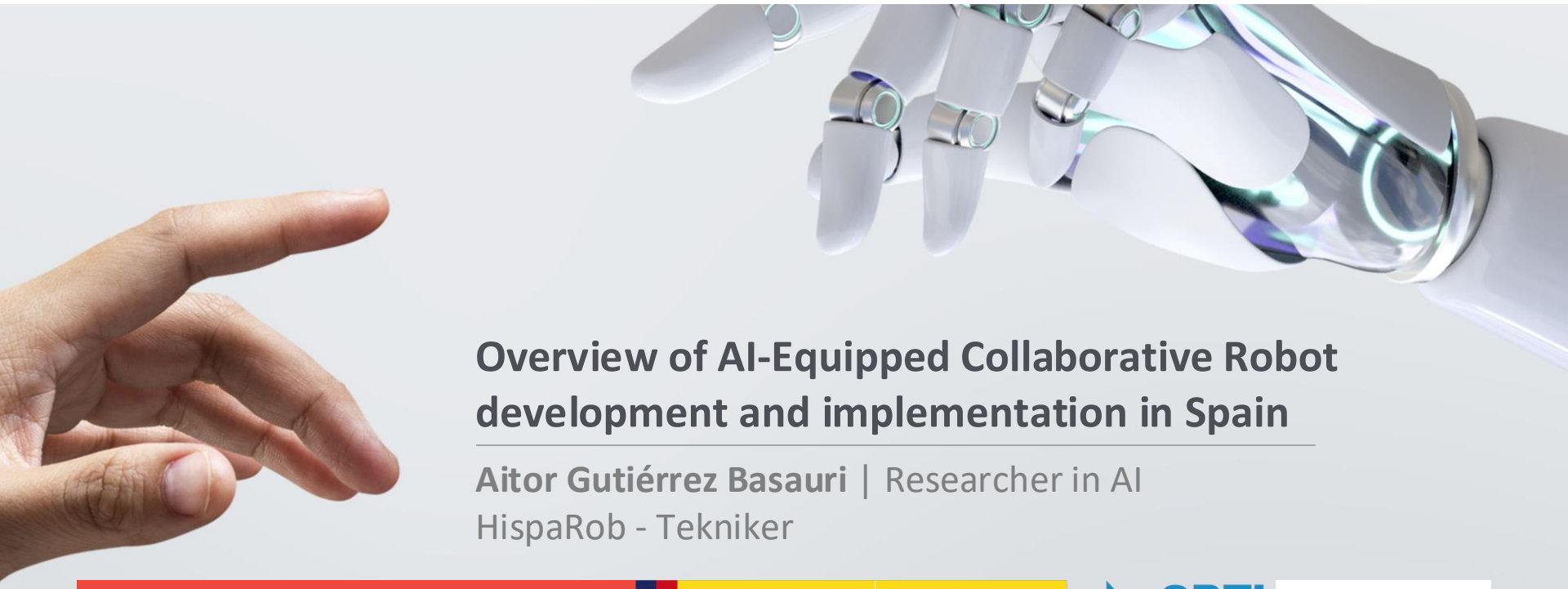
13th CDTI - NEDO Joint Workshop
"AI-Equipped Collaborative Robot Technology"
December 11, 2025 Tokyo

HispaRob



Overview of AI-Equipped Collaborative Robot development and implementation in Spain

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HispaRob - Tekniker

SPANISH ROBOTICS TECHNOLOGY PLATFORM

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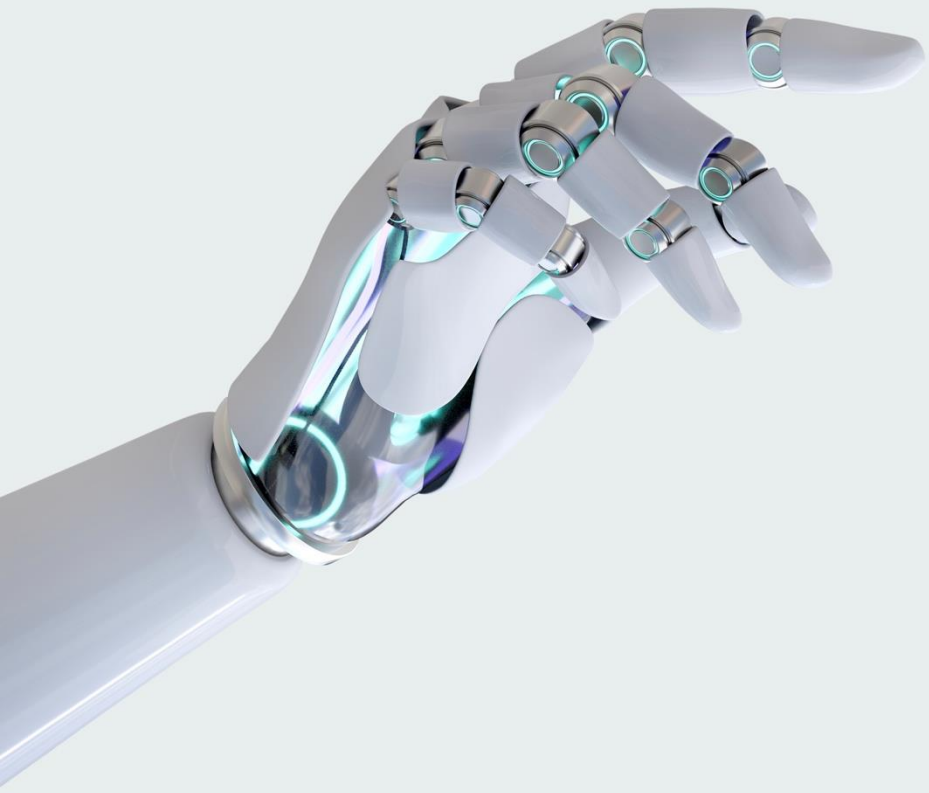
AGENDA



1. **HispaRob:** Spain's Robotics Ecosystem
2. **Overview:** Robotics worldwide and in Spain
3. **AI Layers:** AI research on collaborative robots
4. **Limitations**
5. **Conclusions**

HISPAROB

The Spanish Technological Robotics Platform: **Over 80 members**

MISSION

The goal is to **COORDINATE** innovation, share knowledge, and promote collaboration between industry and research.

HISPAROB is **ECOSYSTEM** that brings together **UNIVERSITIES, TECHNOLOGY CENTERS & COMPANIES**

HISPAROB covers the full journey **from research and development to market-ready solutions**

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Transport and Logistics Robotics

Marine Robotics

Medical and Welfare Robotics

Defence and Security Robotics

Marketing Robotic Products

Air Robotics

Collaborative Robotics

Educational Robotics

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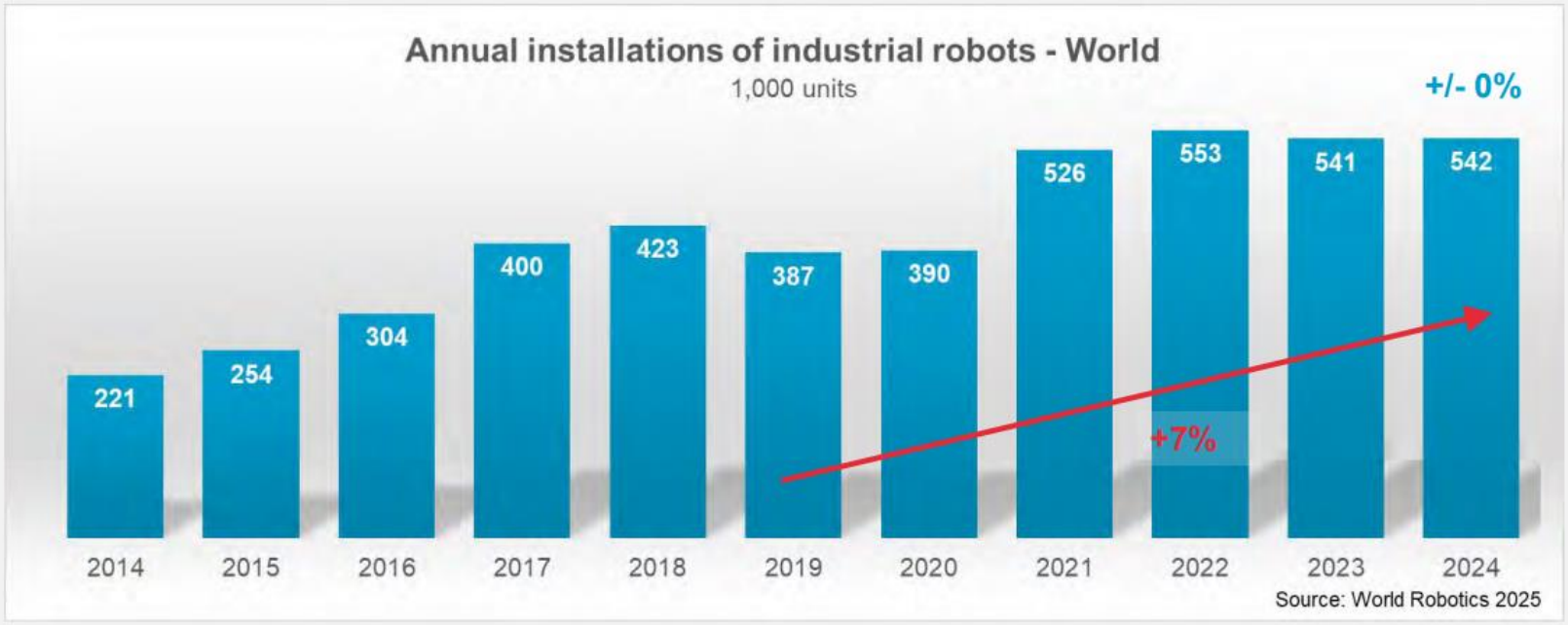
Partners:

Members of:

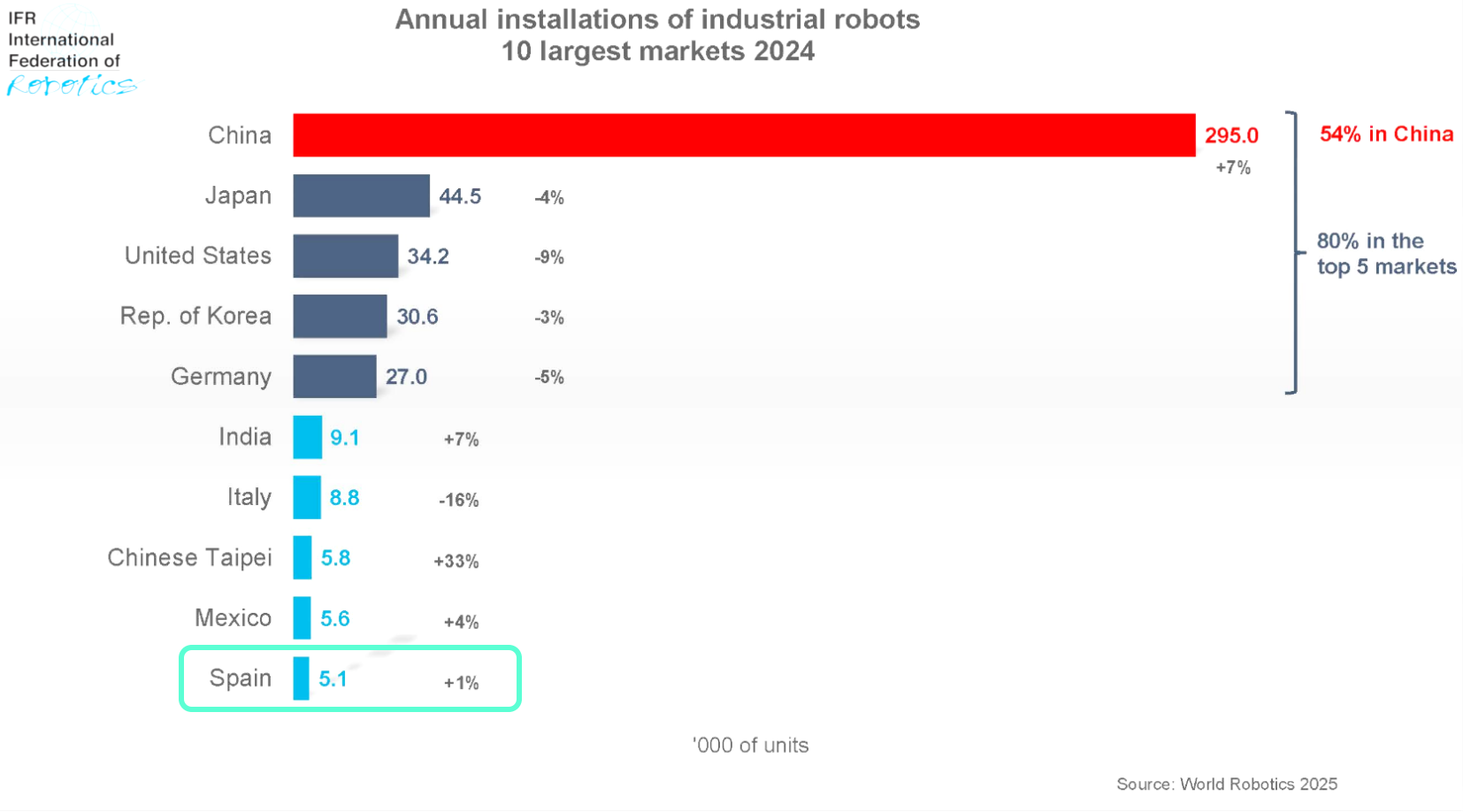
We work with:

Global robot demand in factories doubles over 10 years

IFR International Federation of Robotics

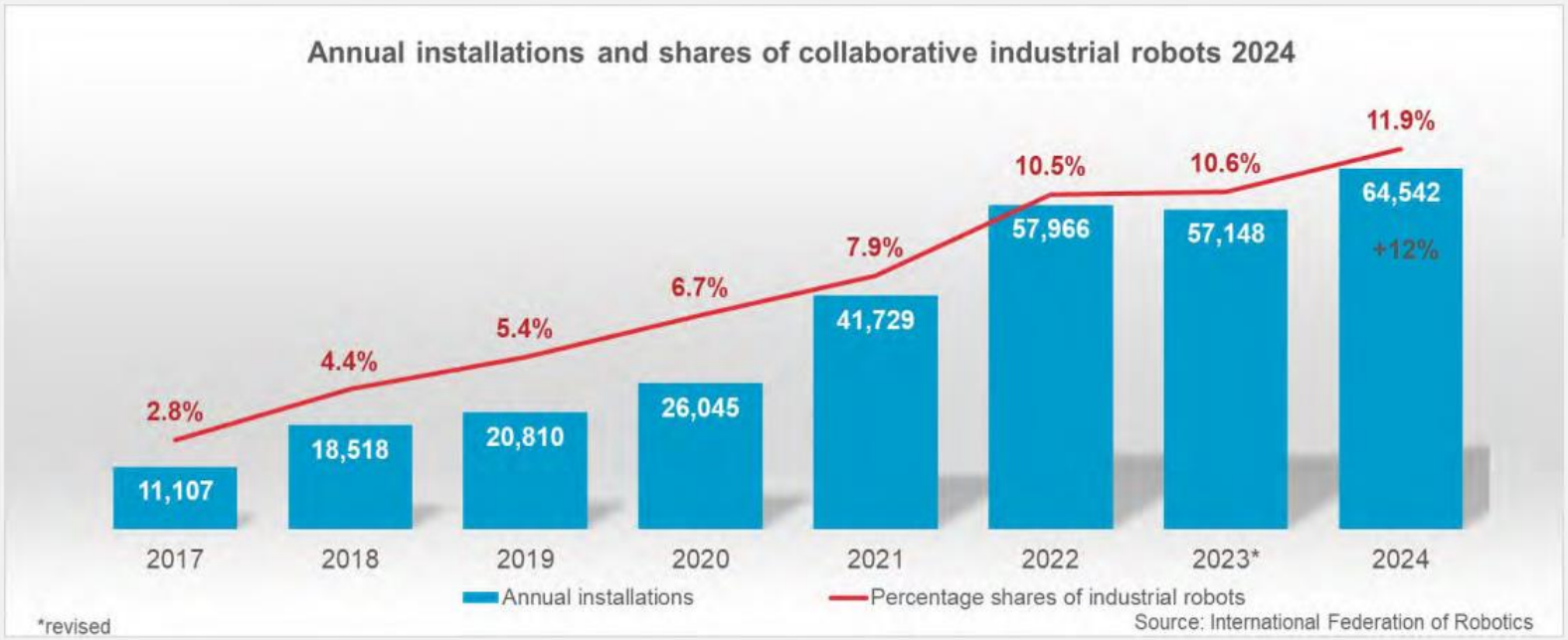


OVERVIEW


IFR International Federation of Robotics
Annual installations of industrial robots
10 largest markets 2024
China
295.0
+7%
Japan
44.5
-4%
United States
34.2
-9%
Rep. of Korea
30.6
-3%
Germany
27.0
-5%
India
9.1
+7%
Italy
8.8
-16%
Chinese Taipei
5.8
+33%
Mexico
5.6
+4%
Spain
5.1
+1%
54% in China
80% in the top 5 markets
'000 of units
Source: World Robotics 2025

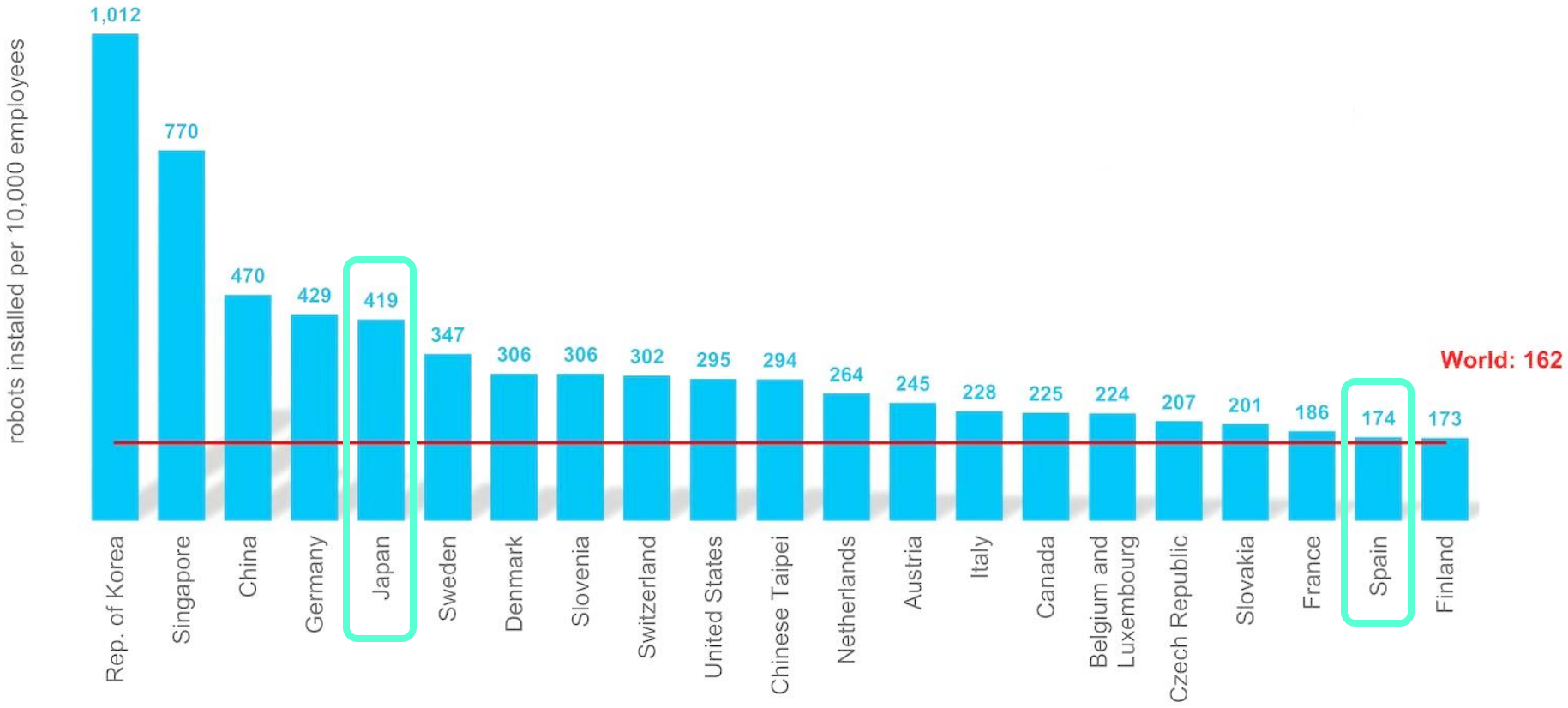
Double digit growth rates of collaborative robot installations

IFR International Federation of Robotics



OVERVIEW

Robot density in the manufacturing industry 2023

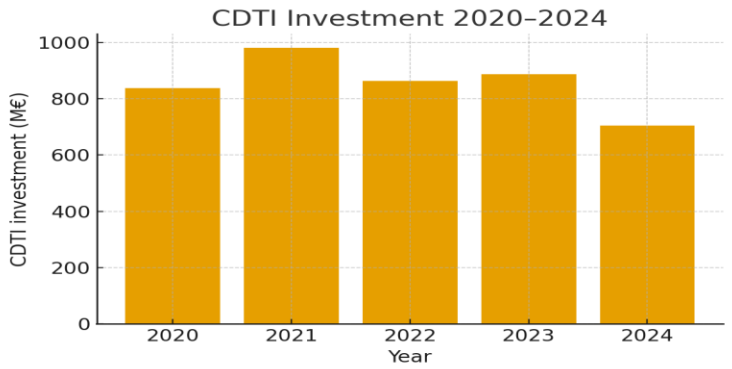


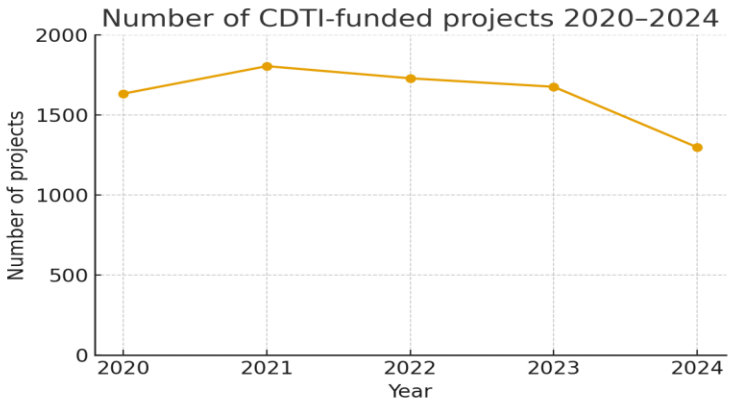
Source: International Federation of Robotics

OVERVIEW

CDTI is the main Spanish government instrument to promote industrial research, development and innovation.

- **Total CDTI projects (2020–2024): 7,146**
- **Robotics projects (2020–2024): 374**
- **Robotics share: ~5% of all CDTI projects**
- **Robotics CDTI contribution: ~243 M€ (2020–2024)**



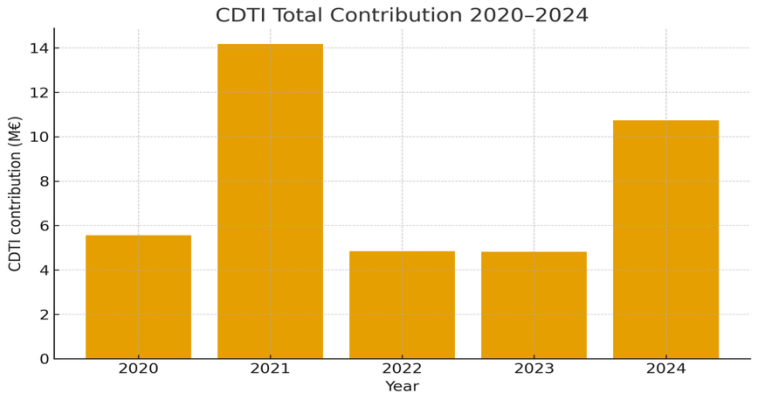


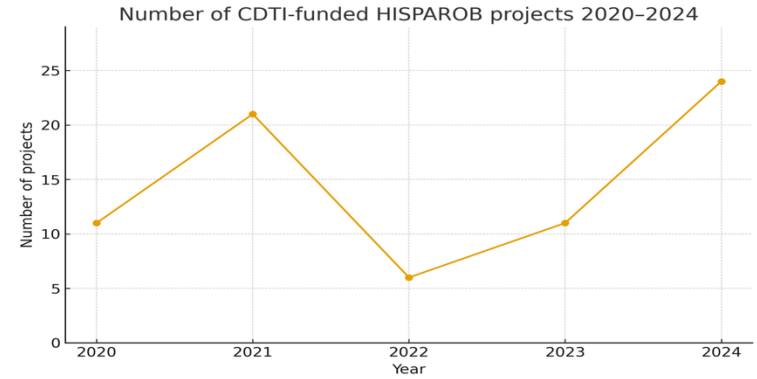
#CDTIDATA

OVERVIEW

CDTI and HispaRob:

- **HispaRob members received between 0.5% and 1.5% of total CDTI funding each year from 2020 to 2024.**
- **HispaRob-funded projects grow from 11 projects in 2020 to 24 projects in 2024.**
- **CDTI contribution to HispaRob increases from 5.56 M€ in 2020 to 10.74 M€ in 2024.**
- **Across the period, HispaRob captures 39.0 M€ of CDTI support through 73 projects.**

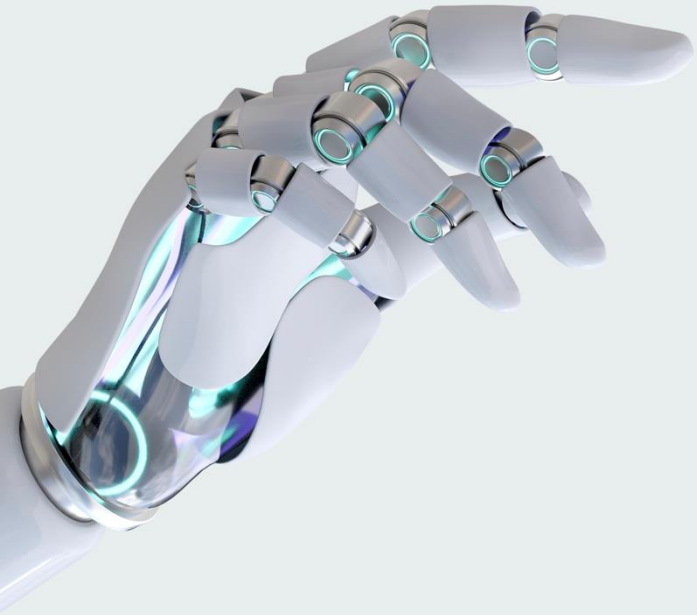


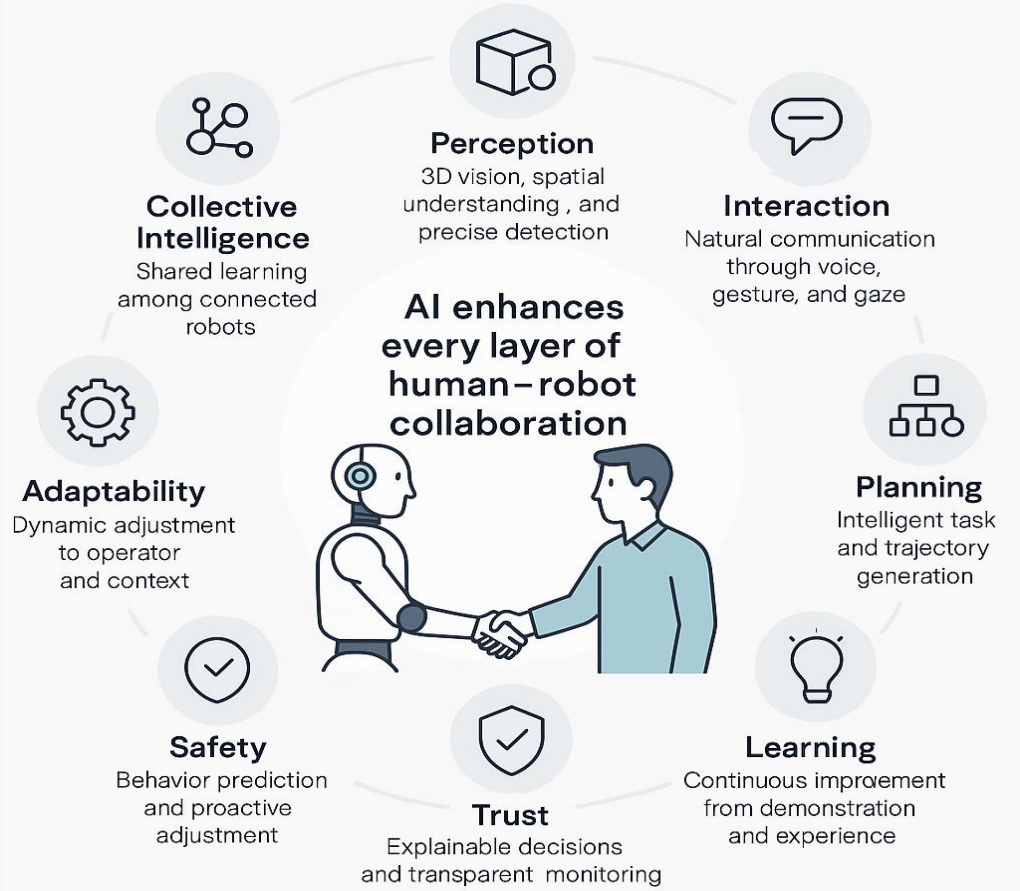


#CDTIDATA

Hispa Rob

AI LAYERS





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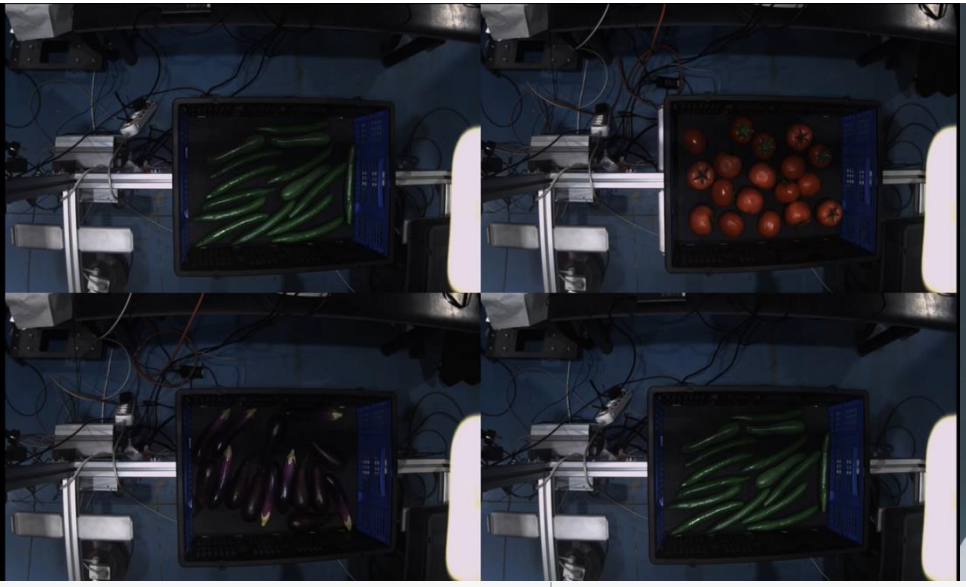
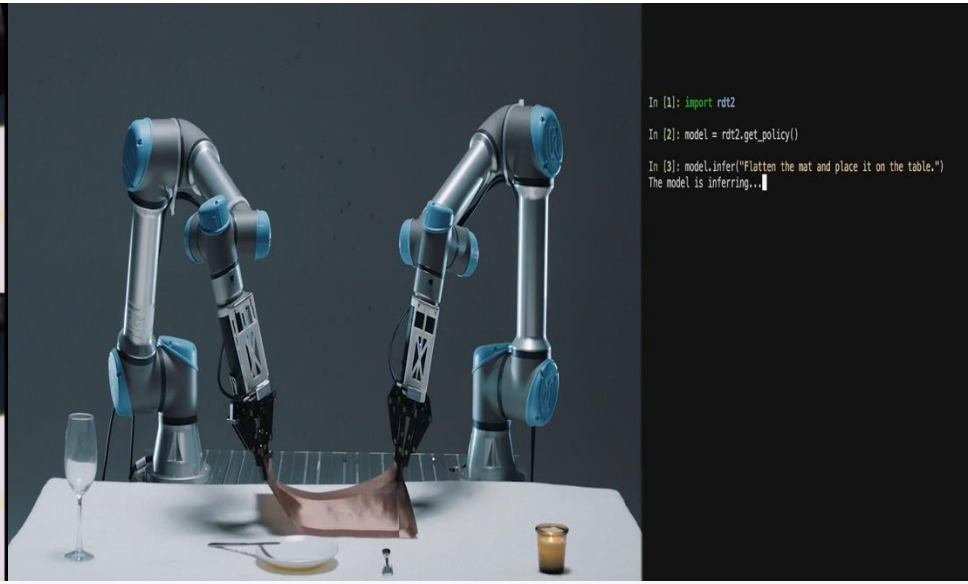
PERCEPTION





Perception

"seeing and understanding"

- **Deep learning models**: Object and tool recognition in dynamic environments.
- **Vision-Language Models (VLM):** Recognize and describe scenes.
- **3D Scene understanding**: Build 3D maps with geometry.
- **Pose and keypoint estimation**: Interpret human posture, gesture, and anticipate human motion.
- **Multimodal sensor fusion (RGB, Depth, LiDAR, Thermal):** Robust and reliable perception.

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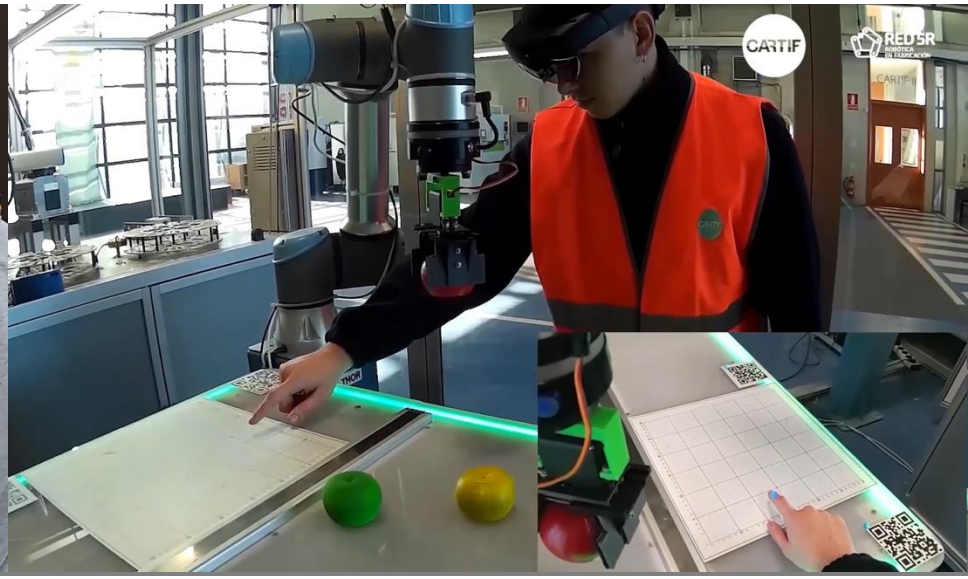
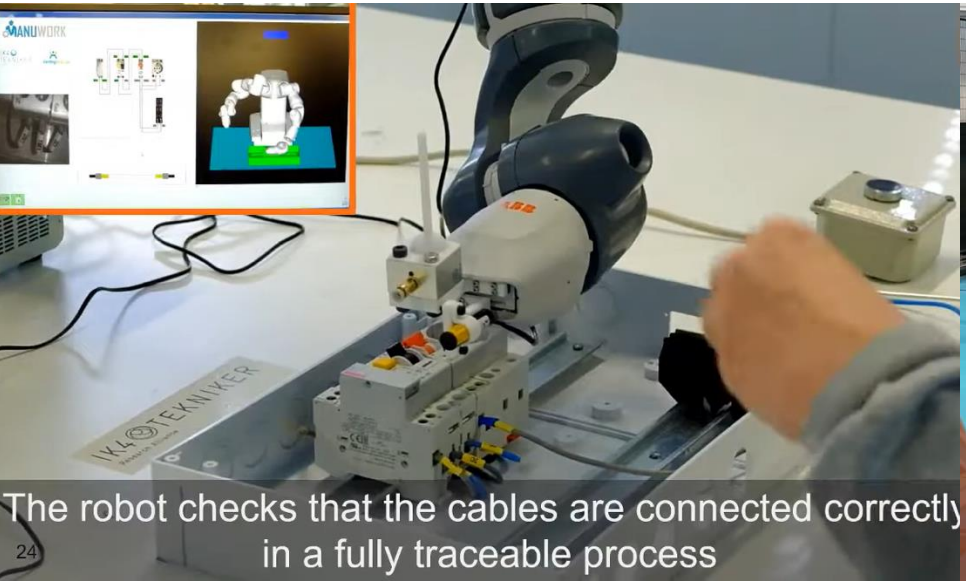
INTERACTION

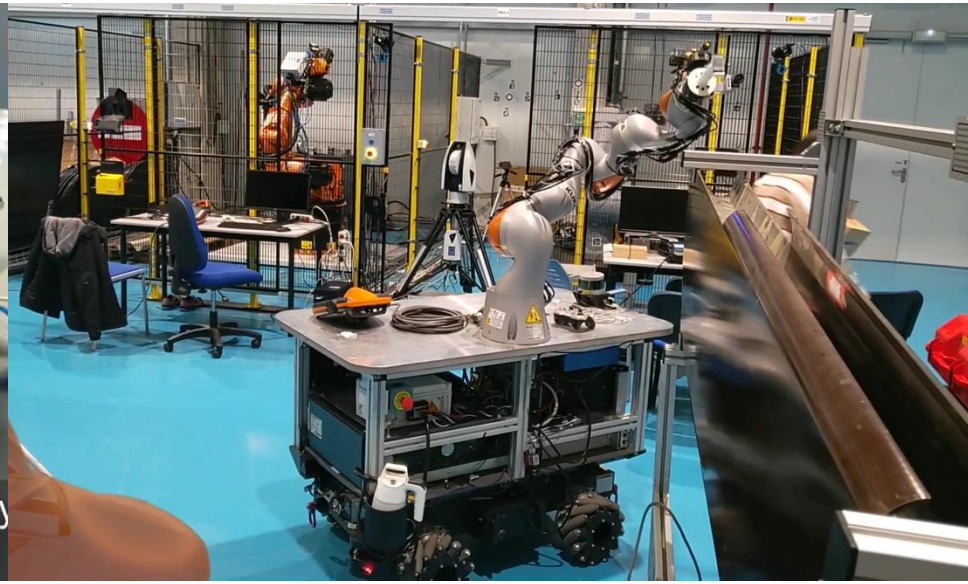


Interaction

"interpreting and communicating"

- **Voice-to-Text and Text-to-Voice models** (Whisper): Enable fluent, bidirectional verbal communication.
- **Large Language Models** (LLMs): Interpret natural instructions and generate contextual dialogue.
- **Gesture and gaze detection**: Decode non-verbal cues for coordination.
- **Emotion recognition**: Allow adaptive tone, proximity, and robot behavior.
- **Multimodal fusion models**: Integrate voice, vision, and text for unified understanding.





Planning

"thinking and deciding how to act"

- **Context-aware planning:** Adjust tasks dynamically according to environment and human position.
- **Semantic planners:** Translate natural language goals into executable robotic actions.
- **Optimization through digital twins:** Validate and improve plans under realistic conditions.
- **Collaborative task allocation:** Coordinate actions among multiple robots and humans.

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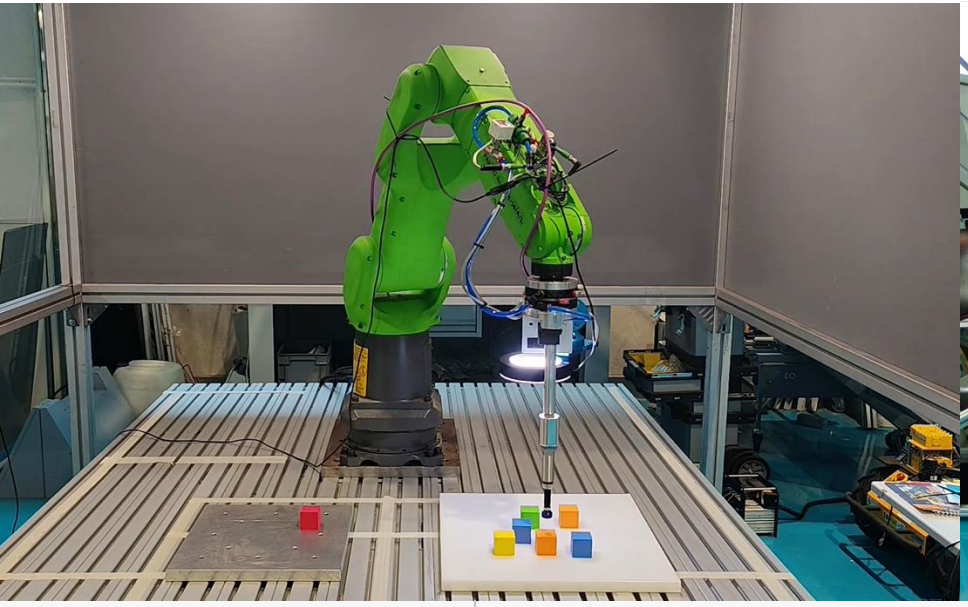
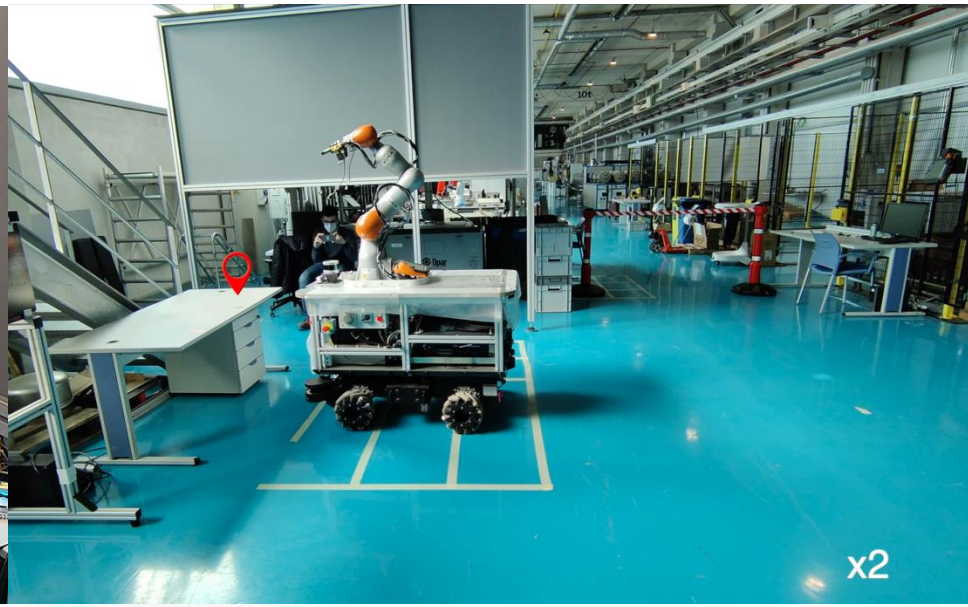
LEARNING



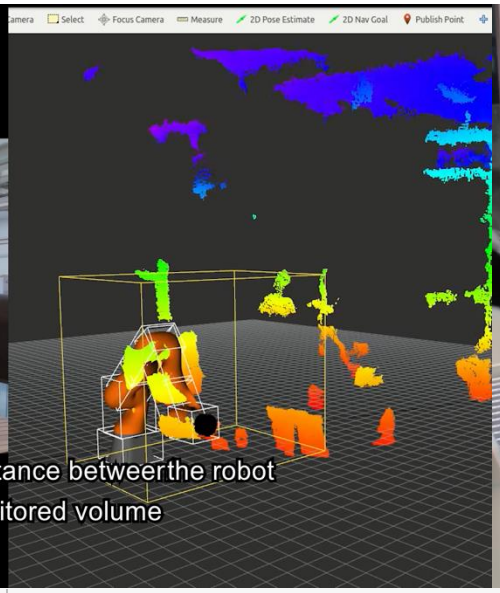


Learning

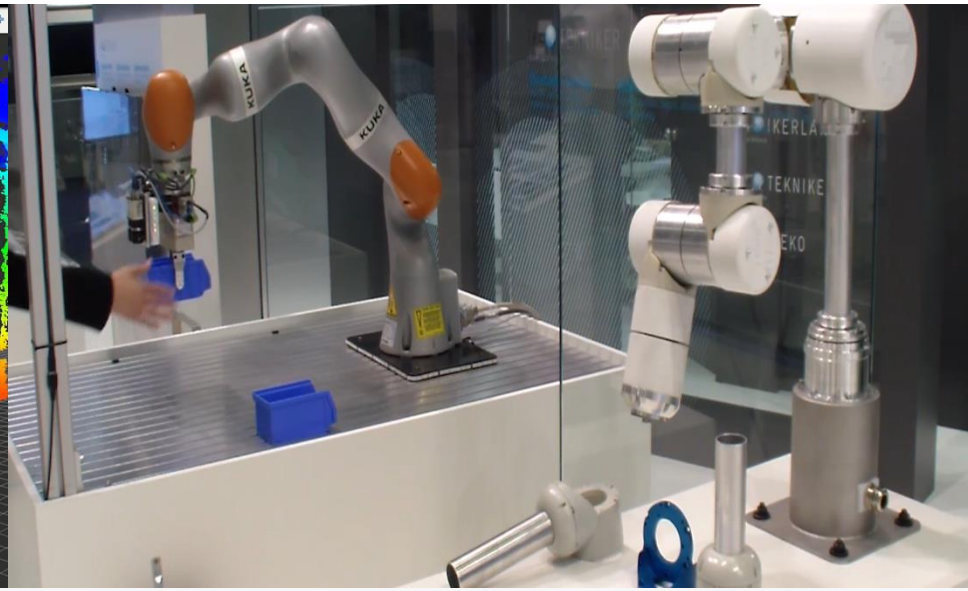
"improving through experience"

- **Learning from Demonstration** (LfD): Allows cobots to acquire skills by observing and imitating human actions.
- **Manual teaching** (kinesthetic guidance): Enable users to physically guide the robot through tasks to record trajectories.
- **Reinforcement Learning** (RL): Refines behaviors through feedback and reward.
- **Sim2Real**: Adaptation bridges from simulation-trained policies to real-world scenarios.
- **Continual learning**: Maintains previous knowledge while integrating new experiences.

SAFETY



PDS computes the minimum distance betweerthe robot and any obstacle inside the monitored volume



Safety

"anticipating and protecting"

- **Human pose**: Tracks body parts in real time for precise spatial awareness.
- **Predictive risk models:** Anticipate collisions and unsafe proximity using AI-based motion forecasting.
- **Speed and Separation Monitoring** (SSM): Dynamically adjust robot speed and force based on human position and movement.
- **Anomaly detection**: Identify abnormal human or robot behaviors to trigger actions.
- **Uncertainty estimation**: Evaluate perception reliability to ensure safe decision-making under ambiguity.

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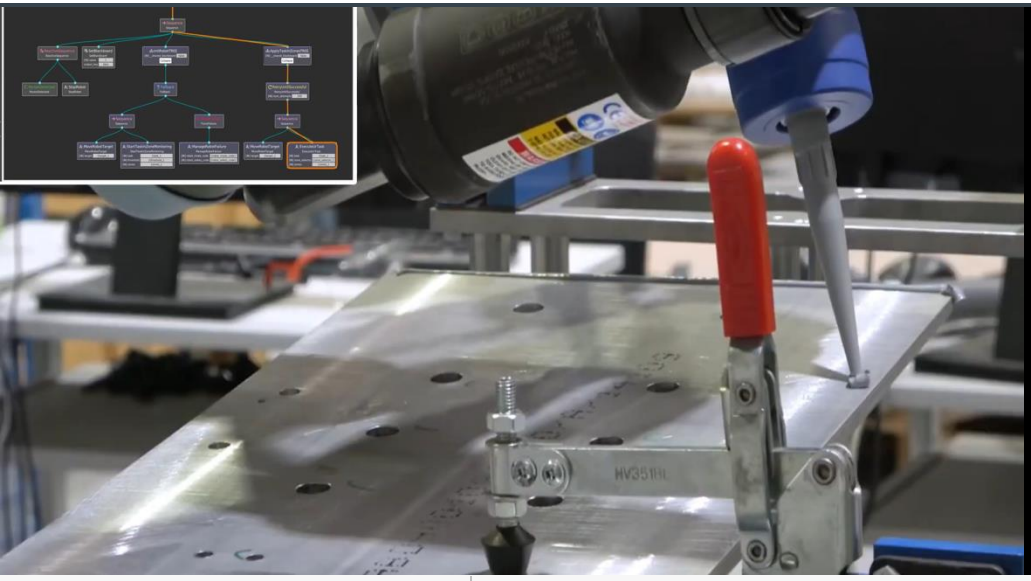
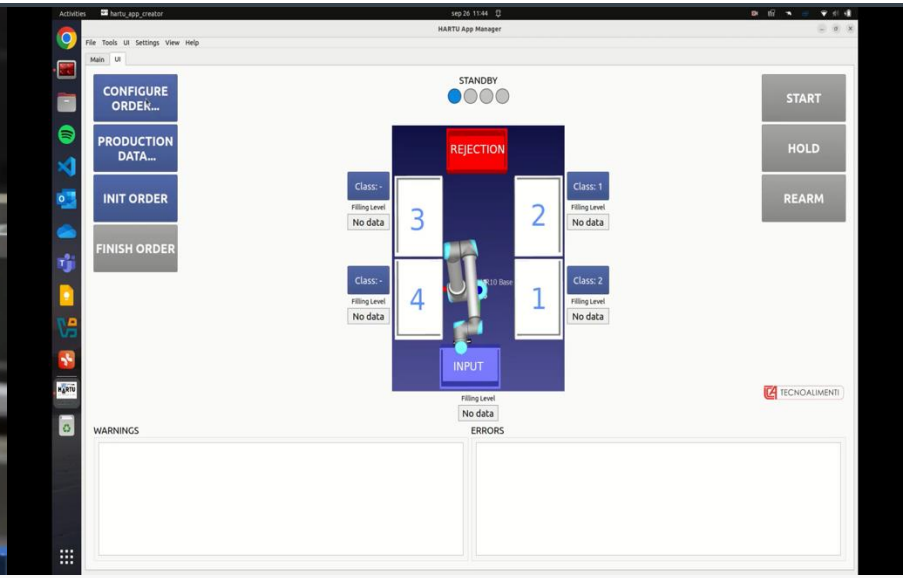
TRUST





Trust

"explaining and justifying"

- **Explainable AI (XAI):** Visualize and understand how and why the robot perceives, plans, and acts.
- **Model auditing**: Trace data, decisions, and model versions to ensure accountability.
- **Reliability:** Quantify model confidence and detect performance degradation.
- **Bias and error detection**: Identify unfair or inconsistent decision patterns.
- **Transparent dashboards**: Display robot state, reasoning, and confidence to operators.
- **EU compliance**: Align with EU AI Act and regulations.

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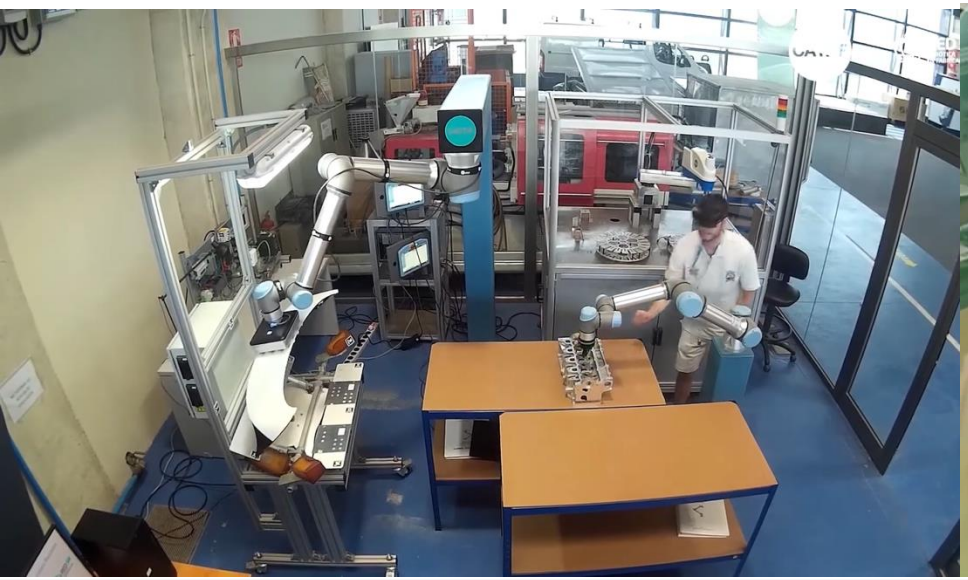
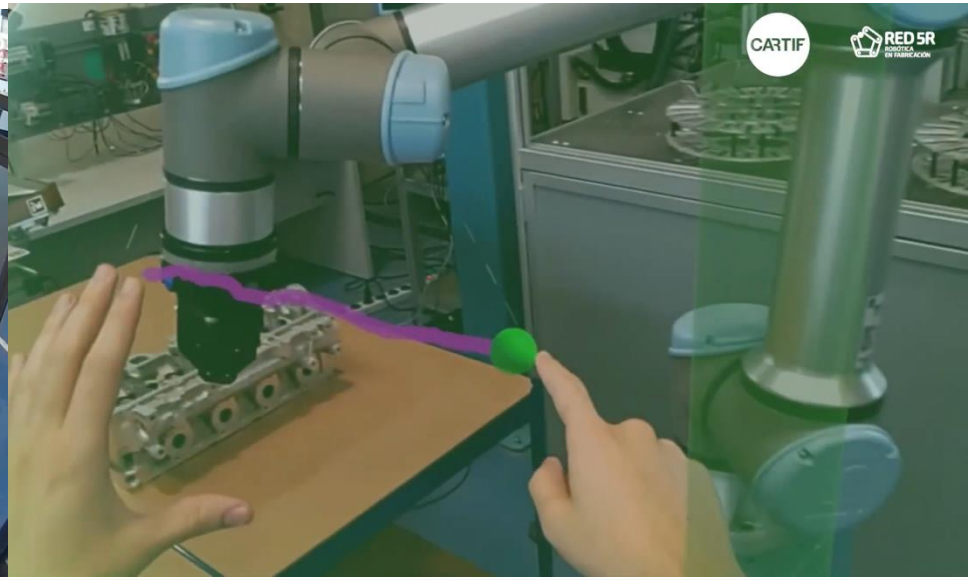
ADAPTABILITY





Adaptability

"adjusting to the human"

- **Personalization**: Tune speed, force, and assistance to operator skill, habits, and ergonomics.
- **Context inference**: Detect task, tools, and workspace state to adapt behavior automatically.
- **Autonomy modulation**: Policies shift between shared-control and full autonomy based on confidence and risk.
- **Continual domain adaptation:** Maintain robustness under lighting, layout, or sensor drift.

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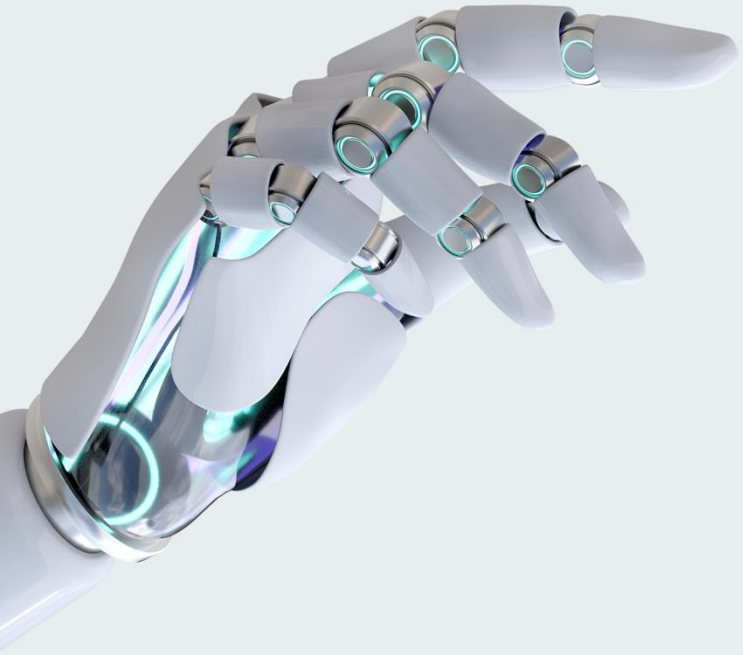
COLLECTIVE

Collective Intelligence

"learning as a network"

- **Federated Learning:** Share model updates across robots without transferring sensitive data.
- **Distributed training:** Synchronize learning across multiple cobots in real time.
- **Policy transfer:** Reuse behaviors and control strategies learned by other robots.
- **Shared memory systems:** Store and exchange experiences to accelerate group adaptation.

LIMITATIONS



Cost vs. perceived value: Many SMEs still see cobots as expensive or unnecessary due to lack of clear ROI data.

The regulatory dilemma: Europe's AI regulations aim to balance innovation with safety but may slow market growth, especially for smaller companies.

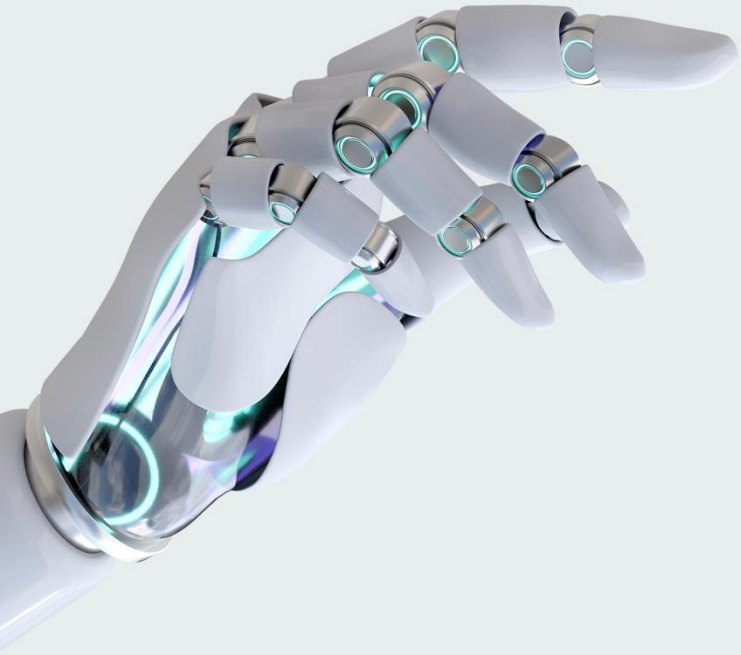
Gap between research, industry, and end users: Innovation doesn't always translate into usable, scalable solutions.

Cultural resistance: Fear of job loss or distrust of automation persists in traditional industries, especially outside automotive clusters.

Skill gap: Operators and engineers often lack training in AI, vision, and safety programming.

Interoperability issues: Integration with PLC, MES and IT systems remains complex.

CONCLUSIONS



Robotics is evolving from safe coexistence to intelligent collaboration.

AI is enabling cobots to plan, learn, adapt and work collectively.

Adoption is still limited by cost, regulation, skills and cultural barriers.

The real opportunity lies in aligning innovation with industrial needs.

Human-centred, trustworthy and scalable AI based robotics will define the next decade.

ありがとう

THANK YOU

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