AI in Motion: From Drones to Autonomous Vehicles

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Overview

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01 Introduction

Aim of presentation

- Showcase current AI-driven capabilities in drones, robotic systems, and autonomous vehicles, with the latest developments across the globe, including Europe and Greece
- Inspire new projects/products by highlighting:
  - Cutting-edge AI methodologies
  - European regulatory environment
  - Greek-specific research and industry activity

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Importance of AI in Mobility

- **Cross-Industry Transformations**: AI-driven autonomy revolutionizes transportation, logistics, agriculture, public services, and inspection sectors globally
- **Key Benefits**: Greater operational efficiency, access to hazardous or remote areas, and safety through human error reduction
- **Societal and Service Impact:** Autonomy addresses societal challenges like aging populations and unlocks novel service possibilities in various domains

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Key Definitions

- **Drones:** Drones fly unmanned either remotely or automatically
- **Autonomous Robots:** Autonomous robots perform complex tasks in diverse fields autonomously
- **Autonomous Vehicles (AVs):** AVs sense their environment and operate independently without human intervention using advanced sensors and AI

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AI Technologies in Autonomous Systems

Key Technologies (1)

- **Deep Neural Networks (DNNs):**
  - Convolutional Neural Networks (CNNs) for object detection/segmentation
  - Transformers for scene understanding and multi-sensor fusion
- **Reinforcement Learning (RL):** control and decision-making process
- **Natural Language Processing (NLP):** Advanced Voice-controlled robotics enabling high-level task instructions

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Key Technologies (2)

- **Sensor Fusion:** Integrates heterogeneous sensor data to achieve robust, accurate environmental perception beyond individual capabilities; Combining sensors compensates for individual weaknesses, e.g., radar's weather resistance with camera's visual detail and LiDAR's depth precision
- **Simulation & Real-world Testing:** Platforms are developed for safe RL training; Waymo’s virtual fleet logs over one billion simulated miles

Applications:
AI for perception

- **Deep Learning Architectures:** CNNs efficiently extract spatial features; transformers enable contextual understanding enhancing perception accuracy.
- **Core Perception Tasks:** Object detection locates agents; recognition classifies them; scene understanding maps environment relations.
- **Frameworks:** TensorFlow and PyTorch frameworks train models for self-driving cars and drones navigating complex scenarios.

Applications:
AI for decision making

- **Reinforcement Learning (RL) Framework:** AI agents iteratively learn optimal policies by trial, error, and reward feedback within dynamic environments.
- **Complex Scenario Adaptation:** RL enables autonomous systems to handle unpredictable tasks beyond predefined rule sets through experiential learning.
- **Simulation for Safe Training:** Simulated environments provide scalable, risk-free platforms crucial for training and validating RL-based decision-making agents.

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Applications:
AI for Human-Computer Interaction

- **Intuitive Control:** NLP interfaces translate spoken or written commands into executable actions enhancing user-system communication efficiency.
- **Voice Recognition and Command Understanding:** Advanced voice recognition combined with semantic parsing allows autonomous systems to comprehend complex human instructions reliably.
- **Emerging Role of Large Language Models:** LLMs promise more context-aware, adaptive, and natural dialogues between humans and autonomous robots or vehicles.

Open source VS Proprietary AI Tools

- Implementations with both open-source and proprietary technology
- Unique benefits of each tool
- Decision of use depends on the region and/of the organization developing the system
- Industry suggests a hybrid approach, using both open-source solutions and developing proprietary, confidential software

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Open source Pillars (1)

- **Robot Operating System (ROS):** developed by Willow Garage and now overseen by Open Robotics. Its modular design supports diverse robotics and autonomous vehicle applications globally.
- **Autoware Full-Stack AV Software:** Built on ROS, Autoware enables Level 4 autonomy features with integrated mapping and control.

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Open source Pillars (2)

- **Apollo Platform Ecosystem:** Baidu Apollo fosters an open ecosystem combining AI modules for perception, planning, and vehicle control software.
- **OpenPilot:** Designed by comma.ai, it is an open-source Advanced Driver-ASsistance (ADAS) software for consumer vehicles, offering features enabling Level 2 autonomy.
- **CARLA (cars) / AirSim (drones):** Platforms used in the research community offer experimentation without starting from scratch.

Proprietary Solutions

- Waymo's "Driver" software by Google/Alphabet in USA
- Tesla's Autopilot/FSD software and neural network pipeline for perception and planning
- Boston Dynamics' control algorithms and AI for its robots' impressive mobility
- Pony.ai and WeRide (China) create their own full-stack autonomous driving

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Real World Applications

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USA

- **Tesla:** Full Self-Driving beta with over-the-air updates, using vision-only sensors.
- **Waymo (f. Google self-driving car project):** robotaxis in Phoenix, San Francisco, Los Angeles, and Austin using Waymo Driver AI.
- **Cruise:** AI-powered Chevrolet Bolt-based robotaxis in San Francisco.
- **Nvidia:** NVIDIA Drive Platform provides AI computing hardware for developing autonomous features.
- **Skydio:** AI for obstacle avoidance in drones.
- **Academic and Research Excellence:** Leading universities such as CMU, Stanford, and MIT contribute cutting-edge AI research crucial for autonomous development.

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JAPAN

- **Industry-Government Synergy:** Japanese AI autonomy advances through strong collaboration between automakers, policymakers, and open innovation.
- **Leading Autonomous Mobility Projects:** Toyota, Honda, Nissan pioneer Level 3 and Level 4 autonomous vehicle trials combined with mobility service platforms like MONET.
- **Robotics and Regulatory Frameworks:** Japan excels in industrial robots, humanoid research, drone regulation, and progressive L3/L4 traffic legislation.

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CHINA

- **Government-Driven Ecosystem:** Extensive government policies, funding, and industry coalitions fuel national AI autonomy ambitions intensively.
- **Robust Urban Data & Infrastructure:** Massive urban data and smart city Vehicle-to-Infrastructure (V2X) systems form critical foundations enabling AI autonomy scalability.
- **Diverse Autonomous Innovations:** From DJI drones to Baidu robotaxis and AI chip pioneers, China excels in broad autonomous system deployment.

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SIGNAPORE

- **Government Strategy & Living Labs:** Singapore leverages centralized planning with living labs to accelerate urban AI autonomy deployment and innovation.
- **Multimodal Autonomous Systems:** Integration of autonomous buses, robotaxis, port trucks, and shuttles showcases comprehensive AI-driven mobility solutions citywide.
- **Drone & Robotics Innovation:** Pioneering drone delivery, air taxis, monitoring, and service robots supported by strict safety policies and academic research.

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SOUTH KOREA

- **Chaebol and Government Synergy:** Large conglomerates and government coordinate to accelerate AI autonomy using dedicated test-beds and 5G-enabled infrastructure.
- **Key Industry and Research Players:** Hyundai's Motional JV, Naver robotics, Samsung chip innovation, and KAIST lead cutting-edge autonomous AI research efforts.
- **Urban Air Mobility & Robotics:** Ambitious UAM roadmap with Hanwha and Korean Air trials complemented by service robots in hospitality and healthcare sectors.

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EUROPEAN AUTONOMOUS LANDSCAPE

- **EU R&D Programs:** Horizon Europe funds AI, Robotics, and Automated Mobility research fostering innovation across member states.
- **CCAM Partnership:** Connected, Cooperative and Automated Mobility unites public-private stakeholders advancing cooperative, connected, and automated mobility with cross-border focus.
- **Ethical & Regulatory Focus:** Europe prioritizes safety, security, and ethical AI while harmonizing regulations to enable cross-country autonomous operations.

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EUROPEAN LANDSCAPE REGULATORY FRAMEWORK

- EU Regulations for Automated Vehicles
  - Regulation (EU) 2019/2144: Type approval for automated driving systems (ADS) (effective 2022)
  - Vehicle General Safety Regulation (July 2022): All new cars must include Intelligent Speed Assistance (ISA) – Level 2 autonomy
  - Draft legislation (April 2022) and delegated acts defining requirements for Level 3 and above
- Member State-Level Laws
  - Germany: Autonomous Driving Act (Sept 2021) enabling Level 4 in defined zones; AFGBV ordinance (Feb 2022) on vehicle approval/operation
  - Switzerland: Ordnance on Automated Driving (Dec 2024, effective Mar 2025) allowing self-driving on motorways
- EU AI Act: First European Regulation for AI

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GREEK INNOVATION

- **EU AI Factory in Greece:** EU's planned "AI Factory" hub in Athens for large-scale AI workloads and research; aims to foster European digital sovereignty.
- **Government Support & Strategy:** Digital Governance Ministry spearheads national digital transformation programs promoting innovation and autonomous system readiness.
- **REACTION:** Greek partners deploying AI-driven border surveillance drones under EU's REACTION project.
- **Projects:** "Advancing Sustainable Mobility in Greece: Promoting electric vehicle uptake and SUMPs", Collab between Greece's Ministry of Environment and Energy and the Technical Chamber of Greece to detect and halt illegal construction.
- **Active Academic & Research Ecosystem:** Greek institutions strongly focus on AI, Robotics, and Intelligent Transport research.

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GREEK USE CASES & PILOTS

- **Border Security Pilots:** AI-powered drones detect unauthorized crossings, relay real-time alerts to Frontex and Greek authorities (live since early 2025)
- **Infrastructure Inspection:** HERON project's autonomous ground vehicles and drones inspect road network, 3D mapping via LiDAR, AI for defect detection
- **Autonomous Mail Sorting Robots:** Hellenic Post pilot with small wheeled robots sorting parcels in Thessaloniki, using ROS-based navigation and vision for obstacle avoidance
- **metaCCAZE:** NTUA & OASA collaboration for autonomous electric minibus trials along fixed routes in central Athens

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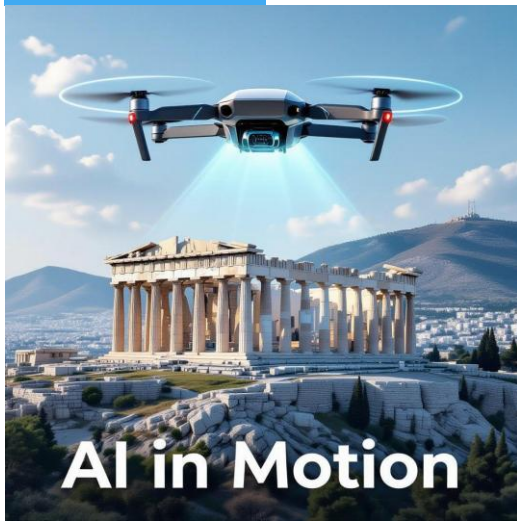

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Conclusions

KEY TAKEAWAYS

- **Global AI** in **drones/robotics/AVs** is maturing (USA, China, Japan, S. Korea, Singapore).
- **Europe** provides **regulatory clarity** (EU regs effective 2022+), **funding** (Horizon Europe, EDF), and flagship **projects** (REACTION, HERON).
- **Greece** is emerging as a regional hub (AI Factory in Athens), active in border surveillance, infrastructure inspection, and smart mobility pilots.

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VIABLE APPLICATIONS IN DIFFERENT SECTORS

- **Smart Transport Applications:** Deploy autonomous shuttles on critical routes like airport, campuses, and pedestrian historical zones improving mobility.
- **Tourism Enhancement:** Implement autonomous shuttles and AI service robots at tourist sites, plus drone shows for event engagement and security.
- **Infrastructure Inspections & Safety:** Use AI-powered drones to inspect bridges, landmarks, power lines, coastal monitoring, and manage crowd safety in public spaces.

… and so many more!

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SOME FOOD FOR THOUGHT

- Which project ideas align best with your organization’s mission and capabilities?
- What are the main technical or regulatory hurdles you foresee in Greece?
- In which sectors can SMEs and PSOs best collaborate to co-fund and co-develop prototypes?

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Any Questions?

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Thanks

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