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Top-level research and data

Creating smart mechano-systems that understand interactions with people and the environment and adapt through the integration of mechanisms, materials, and AI

(Representative papers)

- SPIRA: Small Gas Pipeline Inspection Robot with Spiral Leg-Wheel Mechanism and Single Bending Joint, M. Kamezaki et al., *IEEE Robotics & Automation Letters*, 2025.
- Preliminary Study of Tactical-Level Interaction for Highly-Automated Vehicles: Its Application to Touchscreen Interface, *IEEE Transactions on Intelligent Vehicles*, 2022.

Keyword

- AI Robotics
- Physical AI
- Human–Symbiotic Robot
- Smart Mobility
- Human Sensing
- Human-Machine Interfaces
- Disaster Response Robots
- Infrastructure Inspection and Maintenance Robots
- Functional Materials
- Soft Robotics

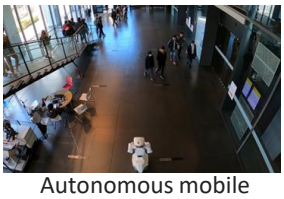
Deployment targets (sites, materials, etc.)

Human–robot shared environments, living environments, transportation and mobility assistance, construction and disaster response sites, infrastructure and plant maintenance, manufacturing and human–robot collaboration

Features (implementation means, etc.)

Our research centers on **interfaces and interactions between humans and intelligent machines**. We combine **"observation, estimation, and adaptation"** with the integration of **mechanisms, materials, AI, and control**. Guided by **Physical AI—which harnesses the physical dynamics of bodies, materials, and environments as components of intelligence—**we treat humans, robots, and their environments as a unified closed-loop system. Our work spans mechanical design, sensing, perception, planning, control, human–machine interfaces, and operation, with the resulting systems validated in real-world settings.

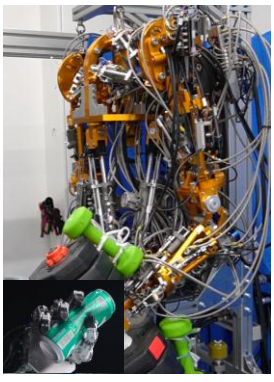
1. **Human–robot coexistence and smart mobility:** Environmental sensing, pedestrian behavior and intention estimation, and mutually coordinated yielding control enable robots and mobility systems to navigate safely and naturally, even in crowded environments.
2. **Human sensing and interaction:** Human states, skills, and intentions are estimated from gaze, body motion, physiological signals, and operational data to support perception, decision-making, and operation in teleoperation, driving, and collaborative tasks.
3. **Robotic mechanisms using functional materials:** MR fluids, functional elastomers, polymers, and other materials are used to develop high-power, backdrivable actuators, soft skins, grippers, and haptic devices.
4. **Field and infrastructure robots:** For harsh environments such as disaster and construction sites and gas and water pipelines, locomotion and manipulation mechanisms, teleoperation, anomaly detection, diagnosis, and repair are designed as integrated systems.
5. **Real-world adaptation and system integration:** Sim-to-Real motion learning, active information exploration, AI, and control enhance adaptability to unknown and changing environments, while industry–academia demonstrations accelerate real-world deployment.



Autonomous mobile robot



Smart personal mobility



Hydraulic robot hand and humanoid



Driver workload estimation



Gas Inspection robot SPIRA



Skin sensor and haptic device



Disaster response robot OCTOPUS

Associated proprietary technologies

- Human–robot coordinated navigation based on human intention estimation and mutual accommodation
- Feasibility assessment, active information exploration, and sim-to-real motion learning
- Human-state estimation based on gaze, body motion, and physiological signals, with teleoperation and driving assistance
- High-power, backdrivable fluid-power actuators and multi-fingered robotic hands
- Long-distance in-pipe locomotion, branch selection, damage detection, diagnosis, and repair
- Functional-material-based soft devices, haptic feedback, and walking-sensation rendering

Associated SDGs



Assumed outlets / applications

Autonomous mobility and mobility assistance services designed to operate safely alongside people; automation of hazardous tasks and reduced staffing needs at disaster response and construction sites; inspection, diagnosis, and repair of aging gas and water pipelines; safe human–robot collaboration in manufacturing and logistics; and physical assistance, caregiving, and heavy-duty task support using high-power humanoid robots and soft robots.