Towards the Fully Autonomous Lab:

13th CDTI - NEDO Joint Workshop
“AI-Equipped Collaborative Robot Technology”
2025/12/11

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QueeenB

🇯🇵 / 🇪🇸: Shared Demographic: Aging Society

We have been facing aging society but we can not give up science even with less people.

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Pain Points in Wet Labs

Why automation remains difficult and necessary.

Manual operations

- Not scalable
- Human-dependent variability
- High cognitive&physical burden

Long and complex

- Many sequential steps
- Overwhelming cognitive load
- Error risk grows with length

Low replicability

nature

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CAREER NEWS | 20 January 2025

'Publish or perish' culture blamed for reproducibility crisis

Survey of more than 1,600 biomedical researchers also flagged small sample sizes and cherry-picking of data as leading causes of reproducibility problems.

By Laurie Udesky

https://www.nature.com/articles/d41586-024-04253-w

- Person-to-person variation
- Poor standardization
- Hard to trace experiment history

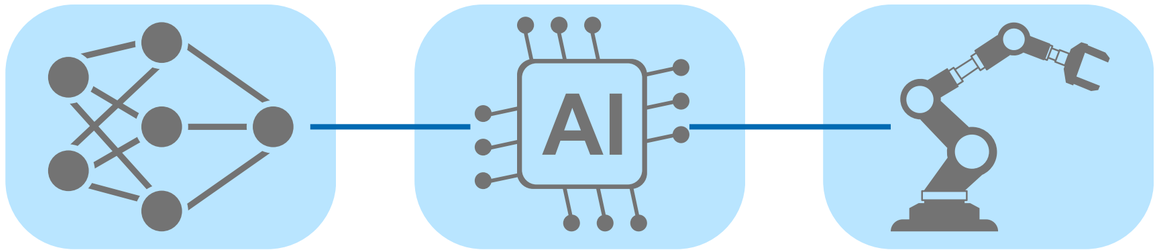
Vision: Fully Autonomous Lab

Humans focus only on thinking. Robots and AI handle the rest.

Vision

A fully automation lab where humans focus on thinking, or just walking.

Core components for fully autonomy

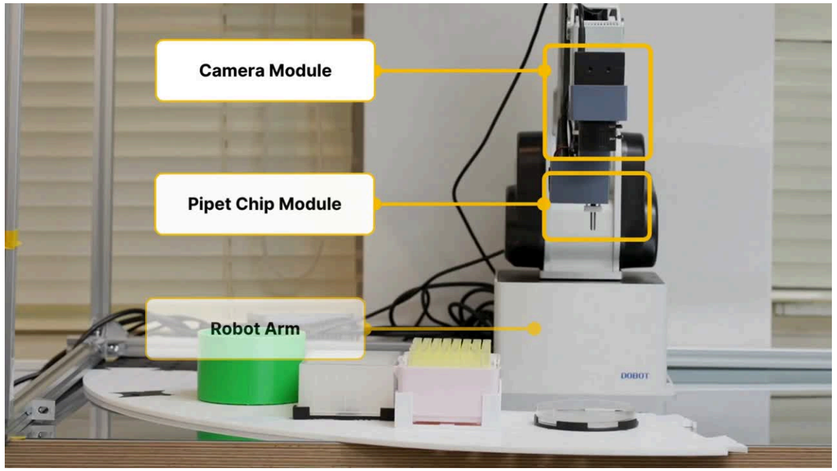


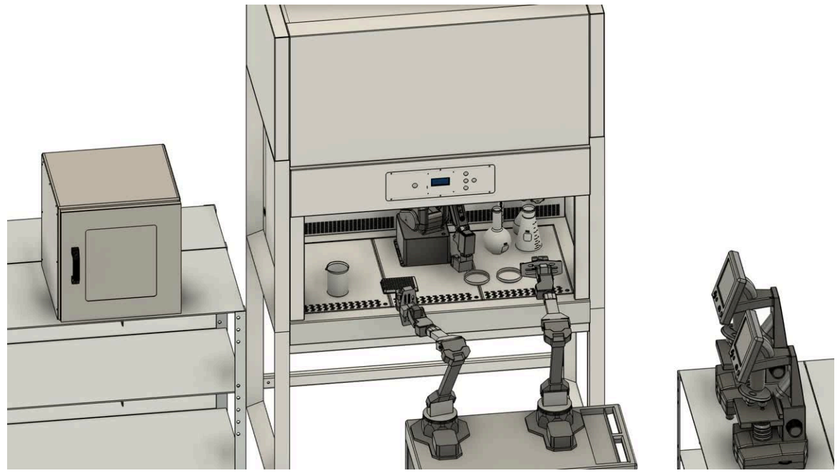
- lab OS
- AI(Physical/hypo)
- Robotics

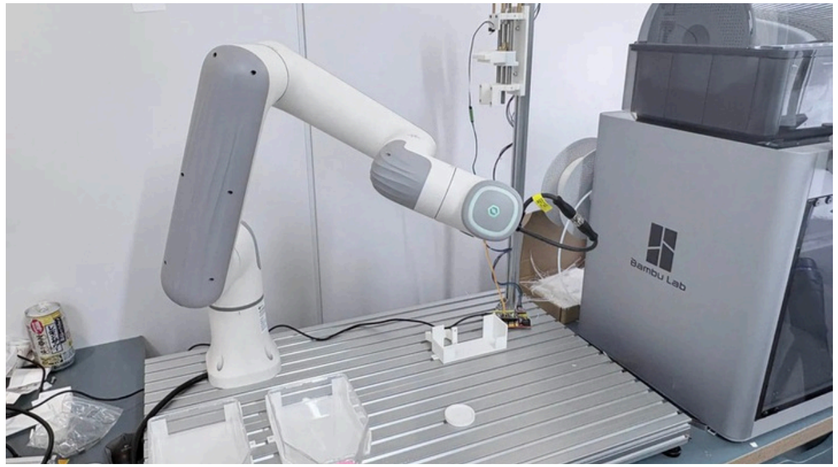
E2E closed loop

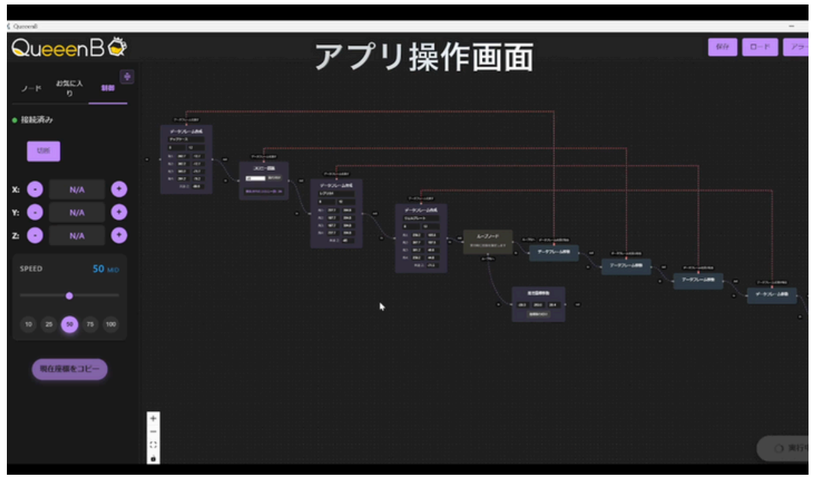
What We Have Achieved So Far

Step-by-step progress toward autonomous laboratories

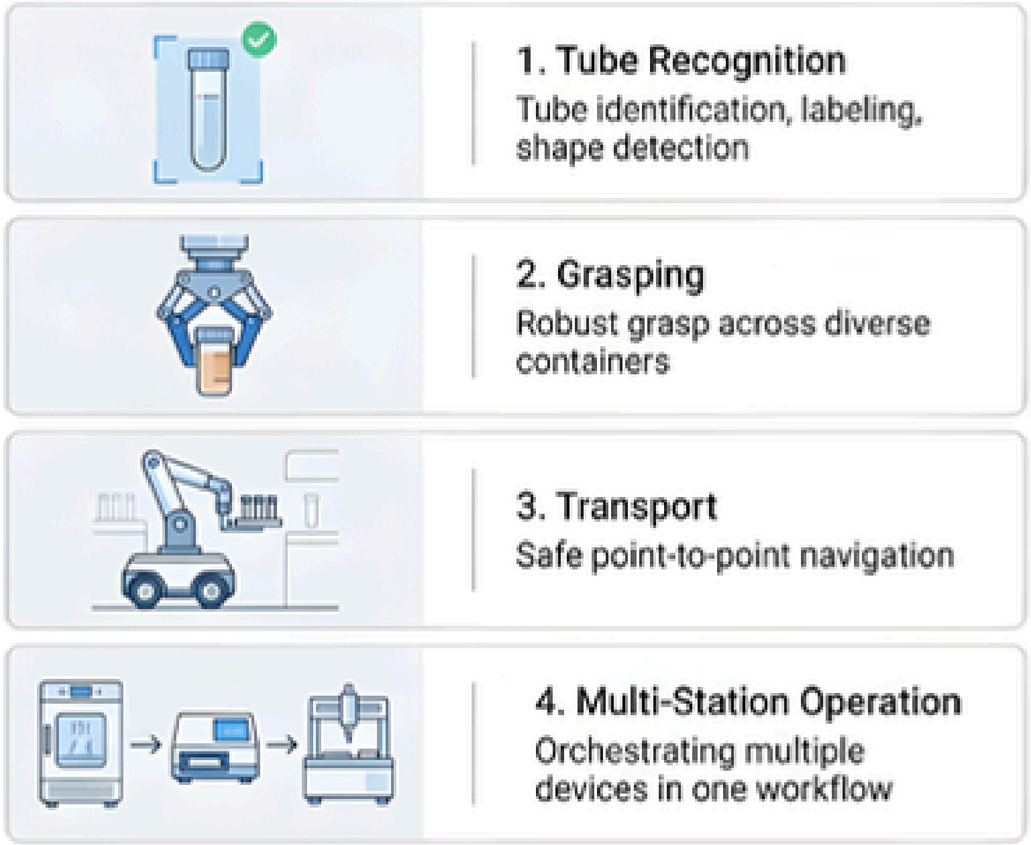








2026 Focus: Mobile Manipulator Automating the Whole Lab with physical ai.

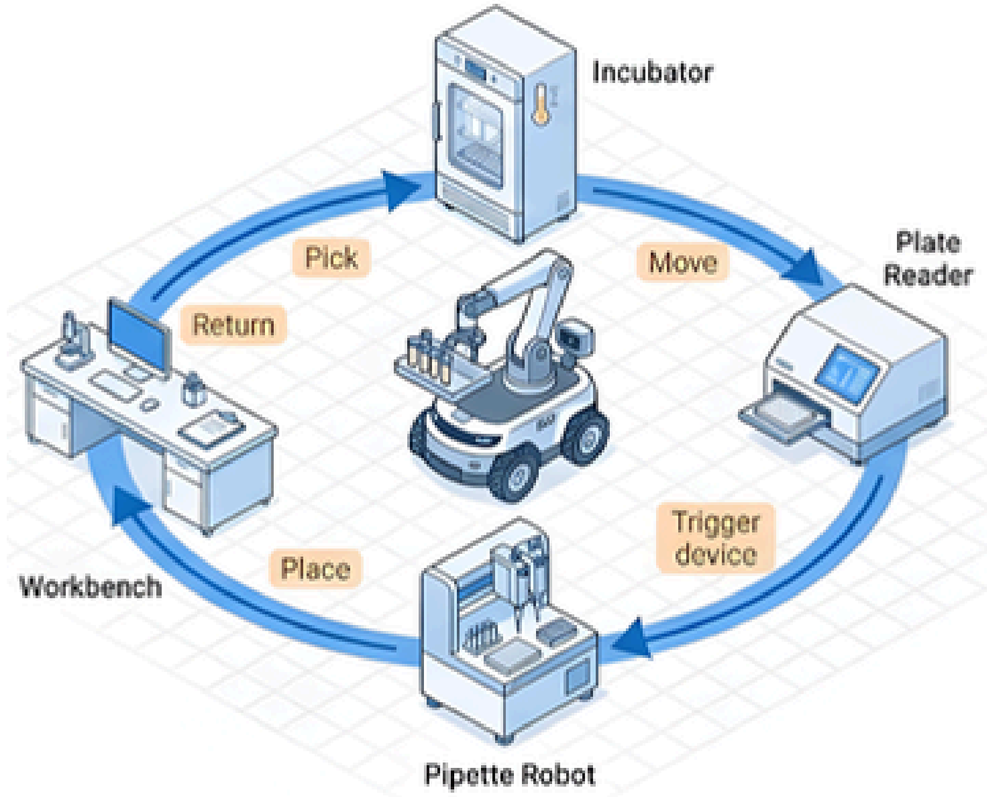


1. Tube Recognition
Tube identification, labeling, shape detection

2. Grasping
Robust grasp across diverse containers

3. Transport
Safe point-to-point navigation

4. Multi-Station Operation
Orchestrating multiple devices in one workflow

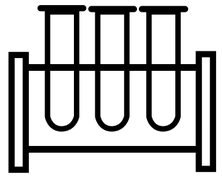


Why Physical AI needed?

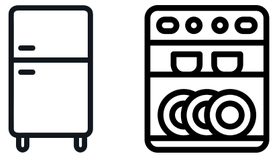
Lab automation fails because of real-world variation. Physical AI rovercome it.

Variation breaks current automation

These small variations stop traditional automation.



Position shifts
(ex. Angles)



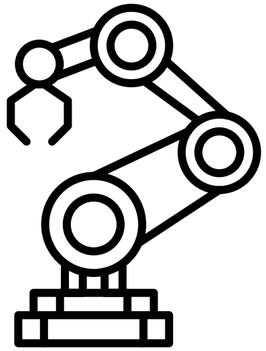
Device-to-device
inconsistency

Environment
Unpredictability

Physical AI replaces brittle rules with adaptive behavior

Physical AI adapts and recovers

Physical AI keeps the workflow moving despite variation.



- **Understands variations**
- **Corrects misplacements**
- **Adaptive reasoning**

Ref:Ochiai, Koji, et al. "Automating Care by Self-maintainability for Full Laboratory Automation." arXiv preprint arXiv:2501.05789 (2025).

Future Design: The Lab Becomes One Product

Seamlessly, researchers do research, without any physical annoyance

—

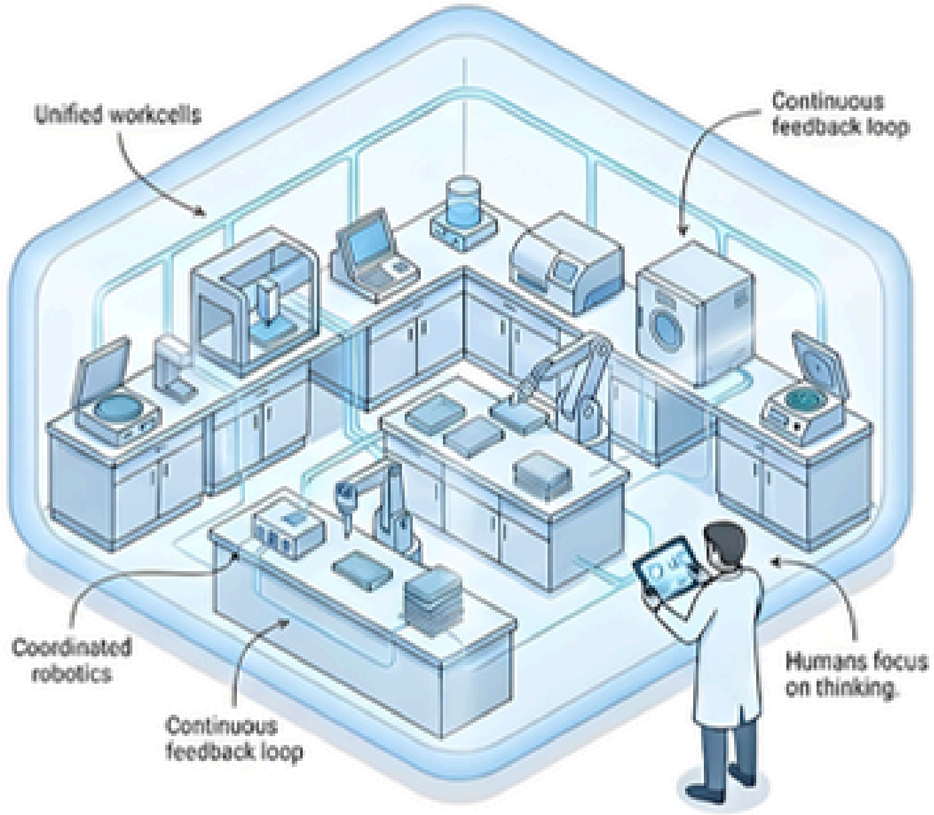
Lab will be alive as if it was human

Our goal is reshaping labs.

AI = Brain
Interprets data, makes decisions, optimizes actions.

Robotics = Body
Executes physical tasks across the whole lab.

LabOS = Nervous System
Connects devices, robots, and data into one coordinated system.



A unified, intelligent platform where humans guide, and the lab autonomously executes.

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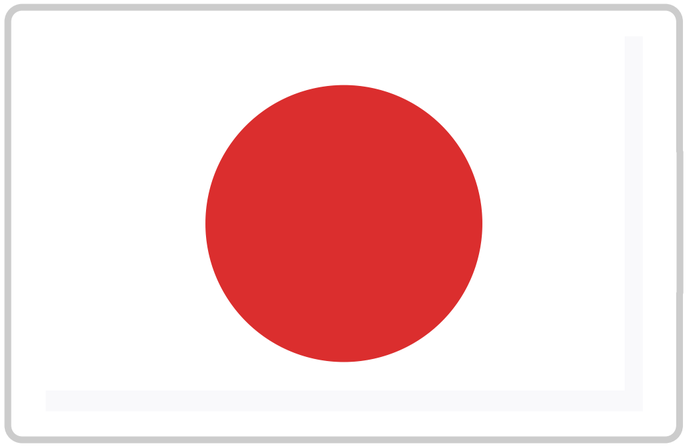
Gracias – Let’s Build the Future of Labs Together

Japan–Spain Collaboration for the Next Generation of Lab Automation



Thank you for your time!