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OCTOBER 2026

**FACTSHEET:
ROBOTIC DISASSEMBLY
OF EV BATTERIES**



Funded by
the European Union

ROBOTIC DISASSEMBLY OF EV BATTERIES

Autonomous, semi-autonomous and human-guided robotic systems

About REBELION

REBELION addresses the waste management challenges of lithium-ion batteries from electric mobility, promoting recycling as a sustainable solution to recover valuable raw materials and support circular battery value chains.

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Key insight

Battery complexity demands: autonomy able to handle different designs and dismantling tasks; interfaces adding human intelligence to hard tasks.

COMPLEXITY OF THE PROBLEM

EV batteries are: extremely complex, multi-scale, unstandardised, not designed for disassembly, and designs change rapidly over time.

ADVANCES IN AUTONOMY 1

Significant advances are needed to make autonomous robots generalisable to handle diversity and changing situations.

ADVANCES IN AUTONOMY 2

Significant advances are needed to make autonomous robots able to robustly handle uncertainty of several types.

HUMAN-IN-THE-LOOP SYSTEMS

Where full autonomy is unfeasible, AI-assisted human control of robots is needed, so that human intelligence can guide remote robots.

DESIGN FOR DISASSEMBLY

In addition to making robots smarter, it will also be necessary to simplify the problem, by re-designing batteries for robotic disassembly.

Why it matters

Critical materials scarcity demands a circular economy approach to achieve electric vehicles at scale. Disassembly should be as non-destructive as possible, to re-use components before recycling raw materials, preserving manufactured value. This poses two major challenges which demand automation: i) enormous numbers of vehicles need large-scale throughput rates – unfeasible for hand dismantling by human labour; ii) EV batteries are high hazard (high voltage, risk of fire, explosion and toxicity) such that human workers should be safely remote from the battery during dismantling.

What are we developing

Firstly, we have developed a variety of advances in autonomous manipulator (robot arms, hands and tools) motion planning and control. Guided by 2D and 3D computer vision systems, force, torque and other sensors, we have demonstrated highly adaptable autonomous robot skills in complex, cluttered and uncertain scenes. These include collision-free motion planning, grasping, cutting and unscrewing, as well as multi-robot coordination and collaboration. Secondly, we have demonstrated advanced human-robot interfaces (HRI), combining VR/AR/XR, haptics, and natural language interfaces. Thirdly, the above two areas of work are being combined as AI-assisted HRI. That is, the autonomous capabilities are used to provide operator assistance, guidance and safeguarding functionalities.

How it works

Advanced autonomous and human-in-the-loop systems.

1

ROBOTIC PERCEPTION

Computer vision and force/torque sensors let robots perceive objects and control contact tasks.

2

AUTONOMOUS MOTION PLANNING

3D scenes are searched for collision free paths and finger placements for secure grasping.

3

FORCEFUL CONTACT TASKS

Force sensors help robots adapt cutting motions to surfaces of different materials and thickness.

4

HUMAN-IN-THE-LOOP: PERCEPTION & GUIDANCE

VR headsets and autonomous motion plans give humans visual and haptic cues to guide them.

5

HUMAN-IN-THE-LOOP: TELEOPERATION

Haptic devices let humans steer remote “slave” robots while feeling their contact forces.

Key benefits

Our research developments (TRL3-5) make autonomous robots smarter and more adaptable, and human control faster, easier, safer.

These are steps towards robotising complex tasks on exceedingly complex and safety-critical objects.

INCREASED SAFETY

Human operators are removed from the hazards of working close to batteries which pose major electrical, fire, explosion and toxicity risks.

SCALABILITY

Robotisation improves the possibilities of achieving circular economy at scale, for massive numbers of end-of-life EVs.

ECONOMIC VIABILITY

Increased automation can make disassembly cheaper, making re-use and recycling economically viable.

WIDER APPLICATION

We have advanced the state-of-the-art in several fundamental robotics capabilities, transferable to many other industries and applications.

Key figures

This section outlines three key aspects of our work.

SYSTEM ARCHITECTURE

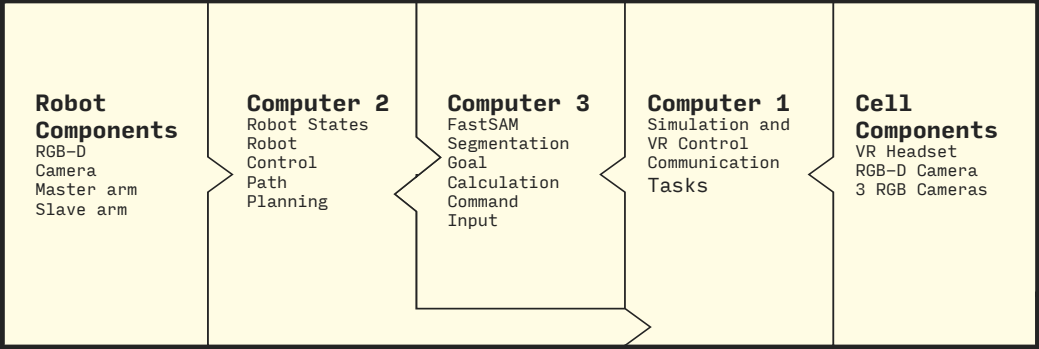
Architecture combining autonomy, teleoperation, and AI-assisted teleoperation modalities.

XR HUMAN-IN-THE-LOOP OPERATIONS

Operator uses a master robot to control a slave robot via XR visualisation.

FULL-SCALE INDUSTRIAL ROBOT DEMONSTRATOR

Industrial robots, actuated positioners, end-effector tooling, Nissan Leaf battery.





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Discover more at:

[> REBELLION-PROJECT.EU](https://rebellion-project.eu)



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