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A High Torque Density and Highly Compliant 7-DOF Collaborative Robotic Arm

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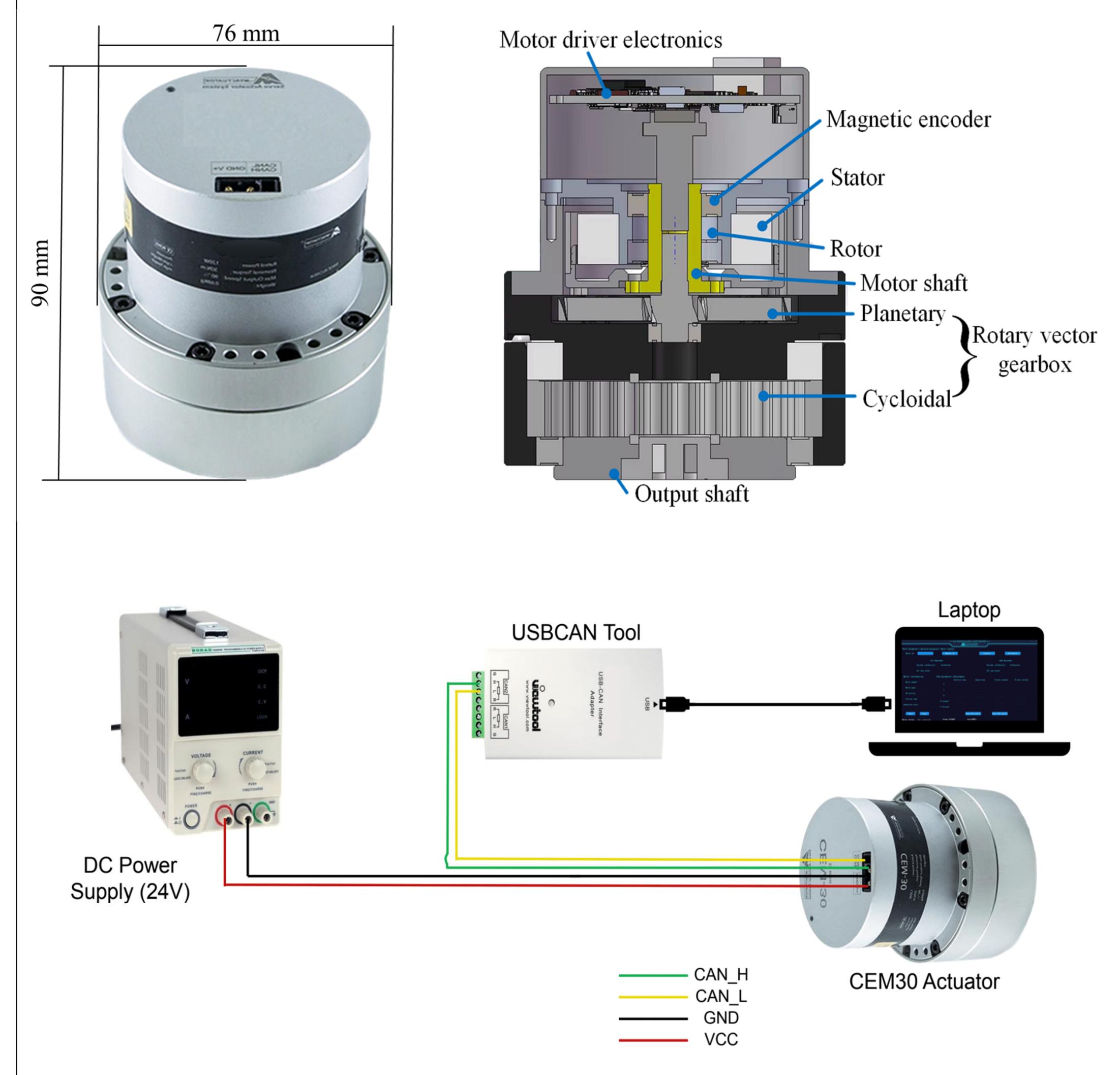


Introduction

- Market demands collaborative robot for tasks requiring both robot and human workers, and need for robotic arms that are flexible, safe, and efficient beyond large robotic arms in isolated environments
- Specific applications such as circuit board soldering [1] and surgical robots [2] require high precision, flexibility and strong back-drivability for safety [3] [4]
- Traditional arms rely heavily on harmonic drive reducers which require substantial space and weight
- The advent of collaborative environments necessitate the development of smaller robotic arms that still maintain high torque and safety compliance

Highly Integrated Compact Rotary Vector Actuators

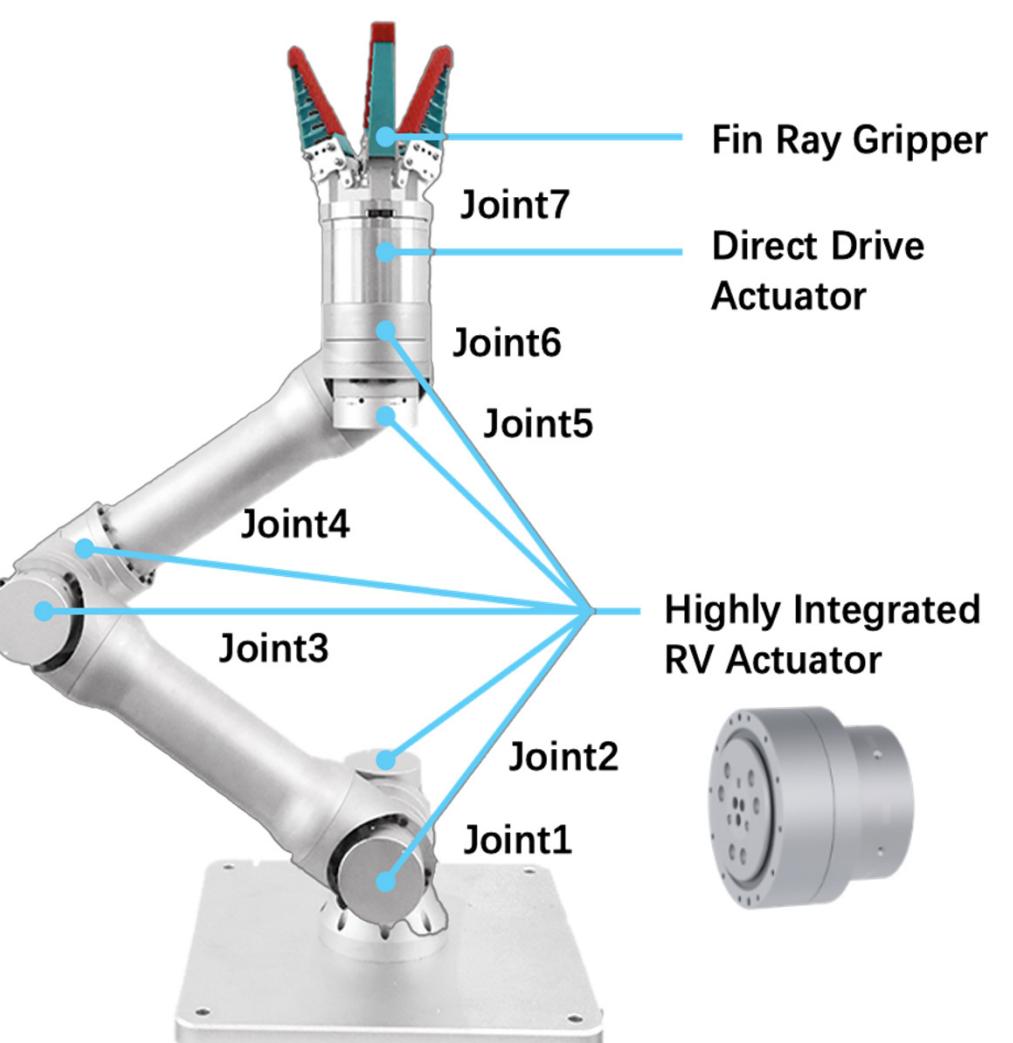
- Rotary Vector (RV) actuators are precision components designed for high torque and large loads, which offer superior load handling and durability while maintaining a compact form.
- Implementing a two-level system of planetary and cycloidal reducers in their mechanism [5]



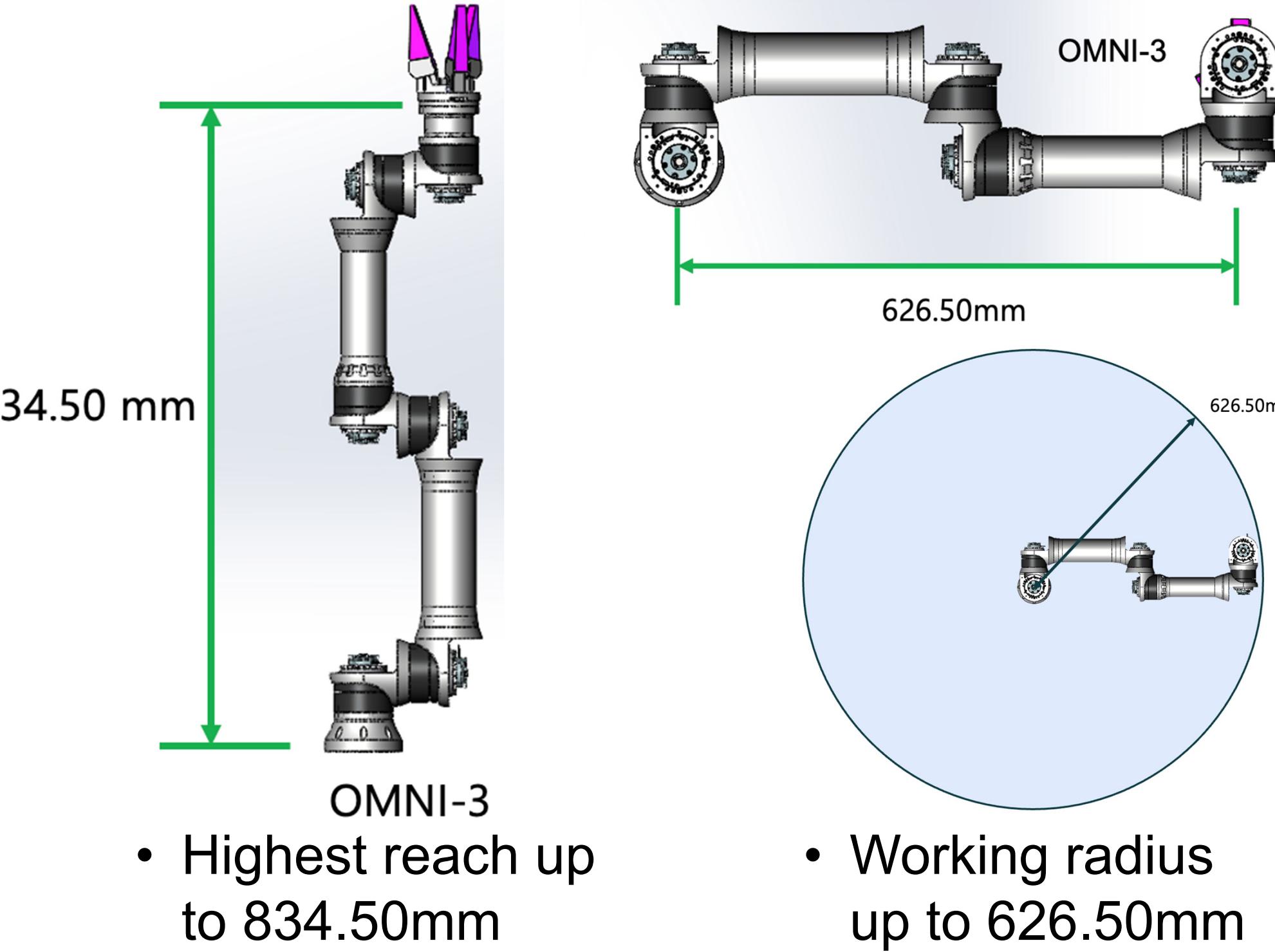
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Modular Design and Fin Ray Gripper



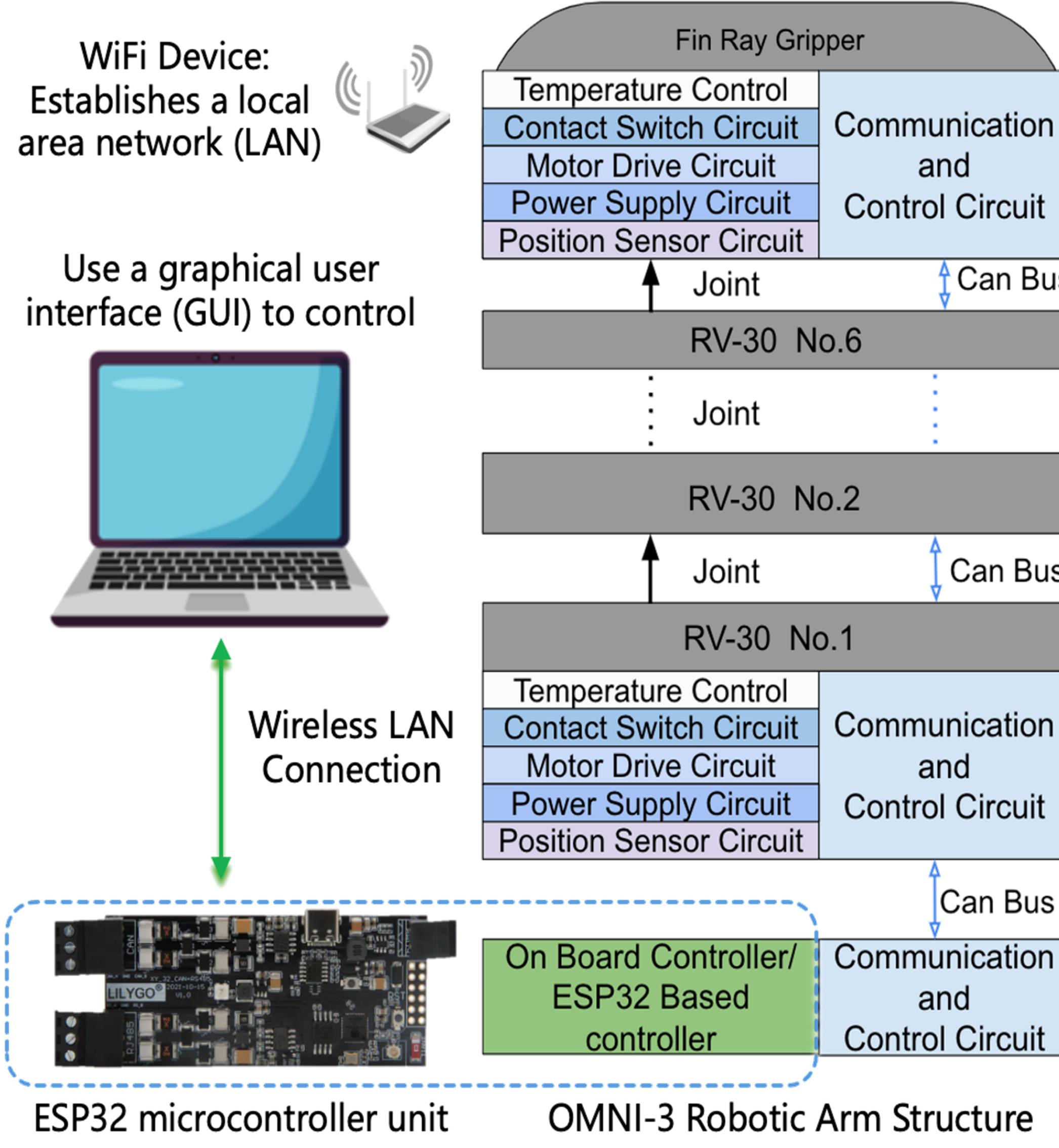
Structure and Joint locations of the OMNI-3 Robotic Arm



- Highest reach up to 834.50mm
- Working radius up to 626.50mm

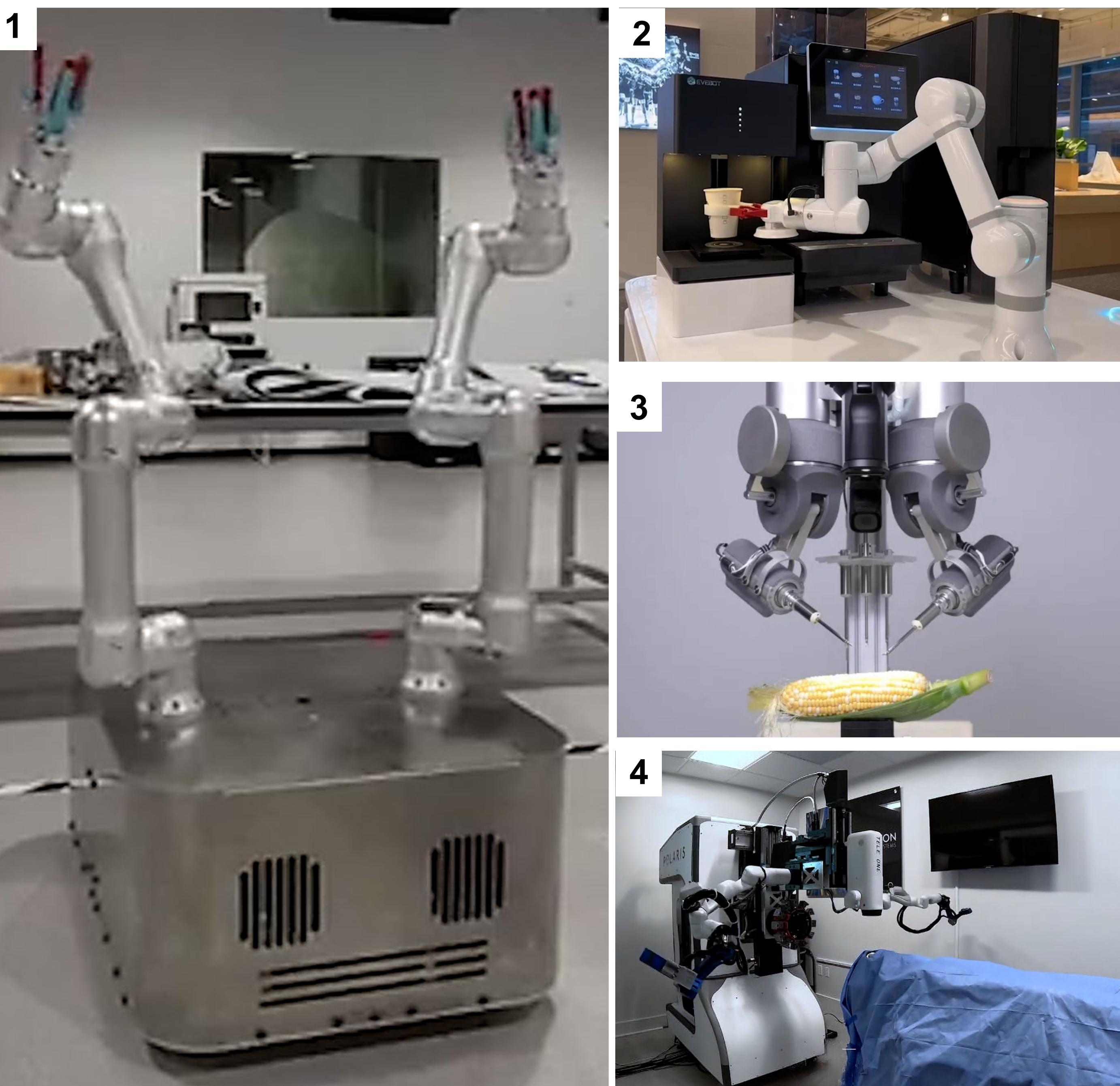
- The OMNI-3 Robotic arm is designed with seven Degrees of Freedom (DOF),
- The first six joints of the arm utilize modular compact RV actuators.
- The seventh Fin Ray Gripper use a RV Linear Actuator.

Communication Architecture



Communication structure of OMNI-3 Robotic arm using LAN and CAN bus connection

Real World Applications



- We envision the high torque and highly compliant Omni-3 robot arm can provide an alternative new solution in real world applications in home services and medical cares, enlightened by the following scenarios:

• Fig. 1 showcases our dual-arm Mobile Manipulator utilizing two Omni-3 robotic arms mounted on a high-torque mobile platform

• Our Omni-3 robot may also be utilized in the food service and homecare, such as a smart coffee machine robot (Fig. 2), and medical care services, serving in the high-precision microsurgery robot (Fig. 3), such as and ophthalmic surgery robot (Fig. 4) for improved surgery outcomes.

Comparative Study

- OMNI-3 maintains a significantly higher payload to mass ratio of 0.4615 compared to other current industry solutions
- The arm exhibits exceptional compliance due to back drivability, enhancing more responsive and adaptive behavior

Performance Comparison

	Mass (kg)	Payload Limit (kg)	Payload to Mass Ratio	Working Radius (mm)
OMNI-3	6.5	3	0.4615	630
UR-3E	11.2	3	0.2678	500
Kinova	5.2	1.3	0.25	900
Mycobot	8.8	2	0.2273	630
RML63-B	10	3	0.3	900
ReBel	8.2	2	0.2439	664
xArm	12.2	5	0.410	700

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