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


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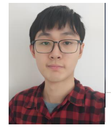
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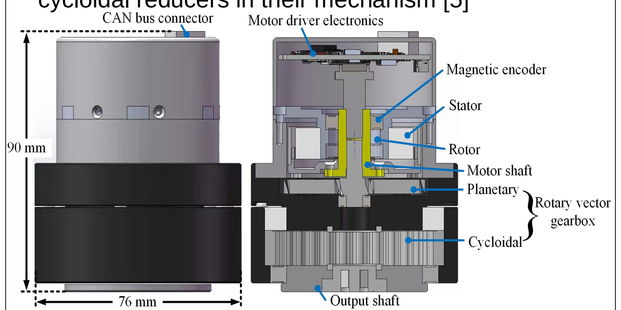
Introduction

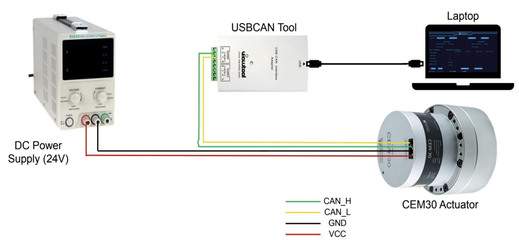
- Market demands collaborative robot for tasks requiring both robot and human workers, and need for robotic arms that are flexible, safe, and efficient beyond large robotic arms in isolated environments
- Specific applications such as circuit board soldering [1] and surgical robots [2] require high precisions, 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]



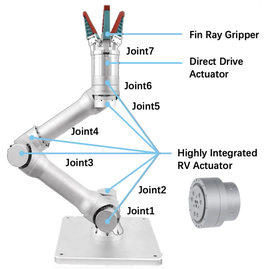
Internal diagram of the Rotary Vector Actuator used in the OMNI-3 Arm



Highly Integrated Compact Rotary Vector Actuators

We would like to acknowledge the support of the NSF Future of Work Program.

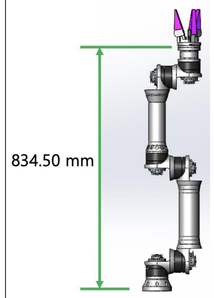
Modular Design and Fin Ray Gripper



Structure and Joint locations of the OMNI-3 Robotic Arm

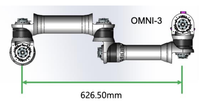
- The OMNI-3 Robotic arm is designed with seven Degrees of Freedom (DOF),
- The first six joints of the arm utilize modular compact RV actuators.
- The seventh Fin Ray Gripper use a RV Linear Actuator.


RV Linear Actuator

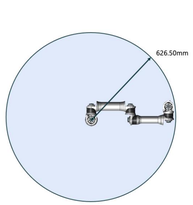


OMNI-3

- High as 834.50mm

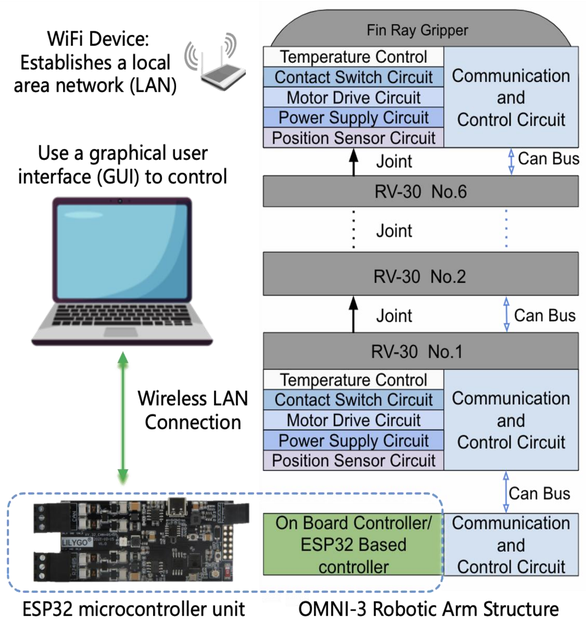


- Working Radius up to 626.50mm



Inner Architecture

Communication Architecture



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

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

Real World Applications

- We currently have a demo showcasing a Dual-Arm Mobile Manipulator (See Fig. 1) that utilizes two Omni-3 robotic arms mounted on a high-torque mobile platform.
- Achieving a highly flexible, bimanual robot with 14 degrees of freedom, capable of performing complex tasks.
- Fig. 2 depicts a smart coffee machine robot. Our mobile manipulator can be programmed with versatile algorithms and be employed in a broader spectrum of applications in the food service and homecare industries.

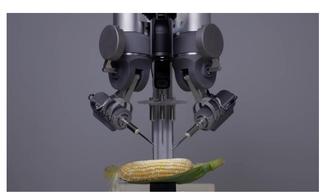


Fig. 3

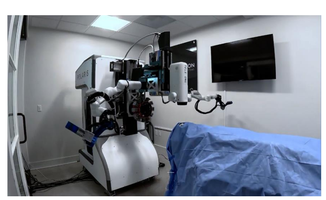


Fig. 4

- Fig. 3 depicts Sony's high-precision eye surgery robot [7]. Fig. 4 shows UCLA's Polaris™ Robot Platform, which streamlines cataract surgery [6].
- By leveraging the flexibility and mobility of our OMNI-3, Our mobile manipulator has the potential to reach the high precision and versatility levels seen in advanced surgical robots.


Fig. 1

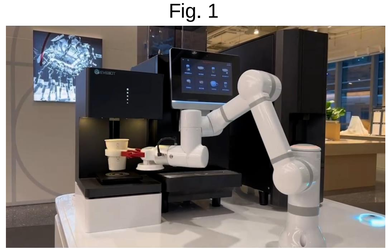


Fig. 2

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