Smart Worker Helper: A High Torque Density and Large Workspace Seven-Axis Robotic Arm

Juncheng Zhou[1], William Zhou[1], and Hao Su[1*]

***Abstract*— Robotic arms can perform a wide range of tasks in industry. Many robotic arms primarily rely on large RV or harmonic drives to provide the necessary torque and precision, and they are mainly used in environments where human-robot interaction is minimized. With the rise of collaborative robots (cobots), small robotic arms that offer high torque, strong back-drivability, a large workspace, and safety have become essential.**

We compared various robotic arm solutions. We conducted a brief study of the current state-of-the-art OMNI-3 robotic arm, which offers advantages in reducing costs, improving energy efficiency, and broadening application possibilities. By utilizing the most advanced rotary vector reducers (RV reducers), our arm's specifications are crucial for operational safety and control.

I. Introduction

As many mechanical tasks require the presence of both c-robots and human workers, the market demands more than just large robotic arms that operate in isolated environments. A more flexible, safe, and efficient robotic arm is necessary. In certain applications within the field of c-robots, such as circuit board soldering and surgical robots, there is a need for not only high precision and flexibility but also strong back-drivability to ensure safety. While many robotic arms on the market attempt to address these requirements, our OMNI-3 robotic arm, based on small motors, stands out. Next, we will compare the performance and advantages of the OMNI-3 with other robotic arms in these key parameters.

II. Specification of the OMNI-3 Robotic Arm

The OMNI-3 robotic arm has a comprehensive set of specifications, making it suitable for a variety of industrial tasks. It features seven flexible joints, including six horizontal movements and one extendable gripper. With a rated load capacity of 3 kg, it efficiently handles medium-duty operations. The arm itself weighs only 6.5 kg, enhancing its mobility and ease of installation. The OMNI-3 has a working radius of 630 mm, As is shown in Figure 1. In terms of energy efficiency, the OMNI-3 is economical, with a typical power consumption of 36 W and a maximum of 240 W, making it cost-effective to operate. Notably, it boasts excellent back-driveability, ensuring operational safety.

III. Comparison of the OMNI-3 Robotic Arm with Other Robotic Arms

We will compare the existing robotic arms from Universal *Robots' UR-3E, Kinova Robotics' Kinova, Elephant Robotics' Mycobot, RealMan's RML63-B, igus GmbH's Rrbel*, and *UFactory's xArm* with our *Omni-3 robotic arm*, as is shown in Table 1.

[1]Department of Mechanical and Aerospace Engineering, North Carolina State University, Raleigh, NC, 27695

[*]Corresponding author's email: hao.su796@ncsu.edu

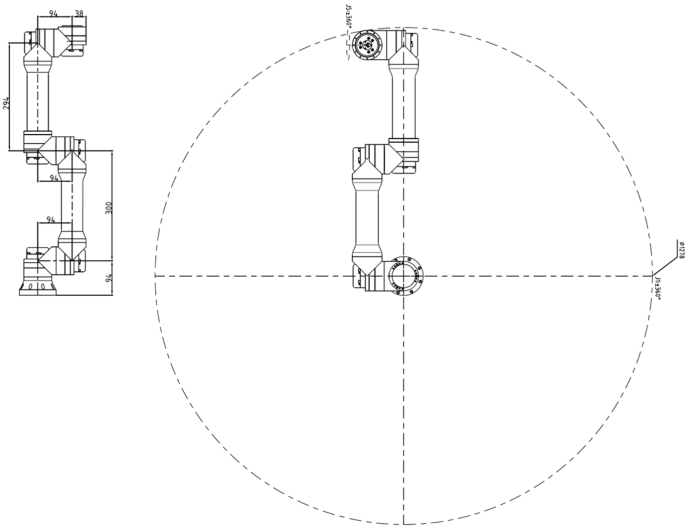

Fig. 1. Robotics arms specification and workspace

TABLE I

Tech specs comparison between various robot arms

	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

- **Payload to Mass Ratio**: The payload to mass ratio of 0.4615 is the highest, indicating superior load handling relative to its weight.
- **Back−Drivability**: Exceptional back-drive smoothness allows manual adjustments with minimal resistance, enhancing safety during human-robot interactions.

IV. Conclusion

In summary, our robotic arms demonstrate significant potential in small motor applications, particularly in terms of safety and human-robot collaboration. The OMNI-3 robotic arm excels with its high payload to mass ratio and exceptional back-drivability, ensuring smooth and safe interactions. These features make it a superior choice for precision tasks in confined spaces