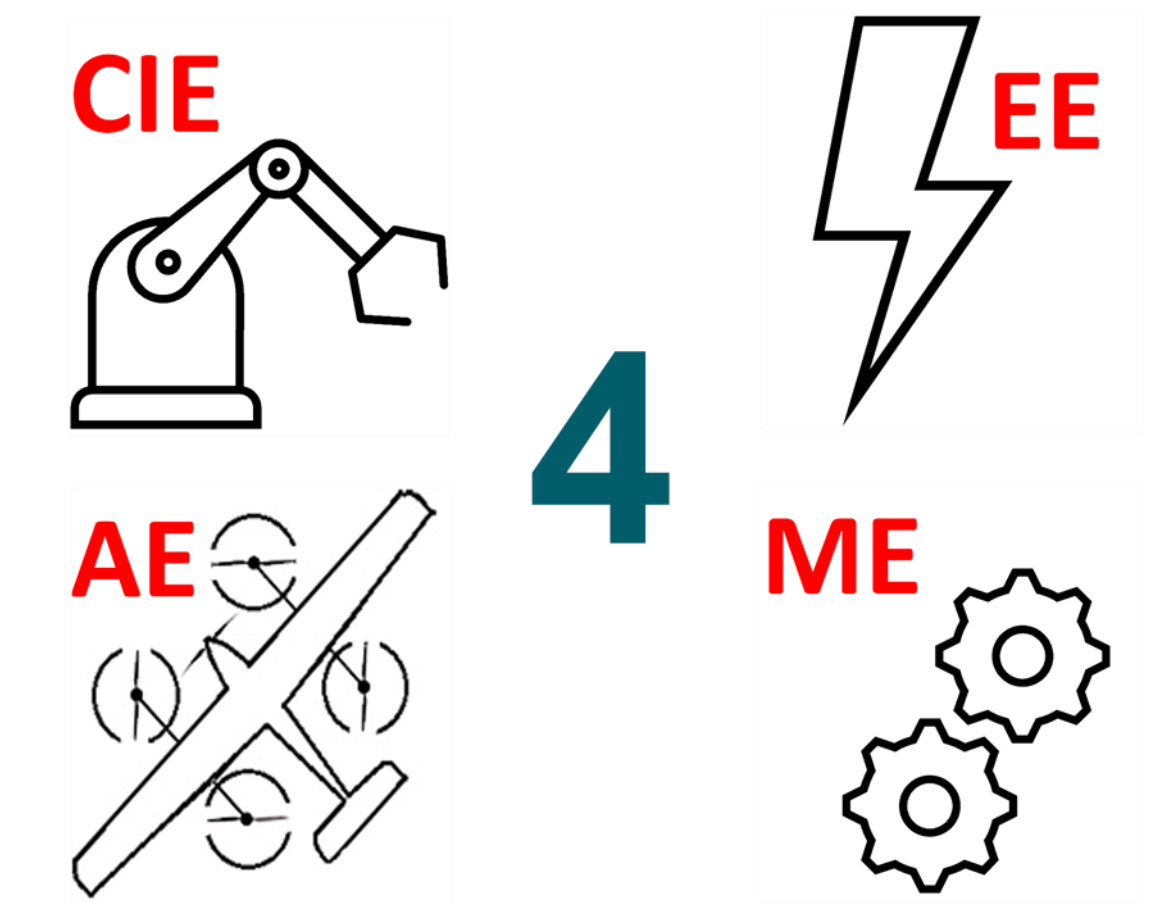


The Semi-Autonomous Date-Harvesting Robot

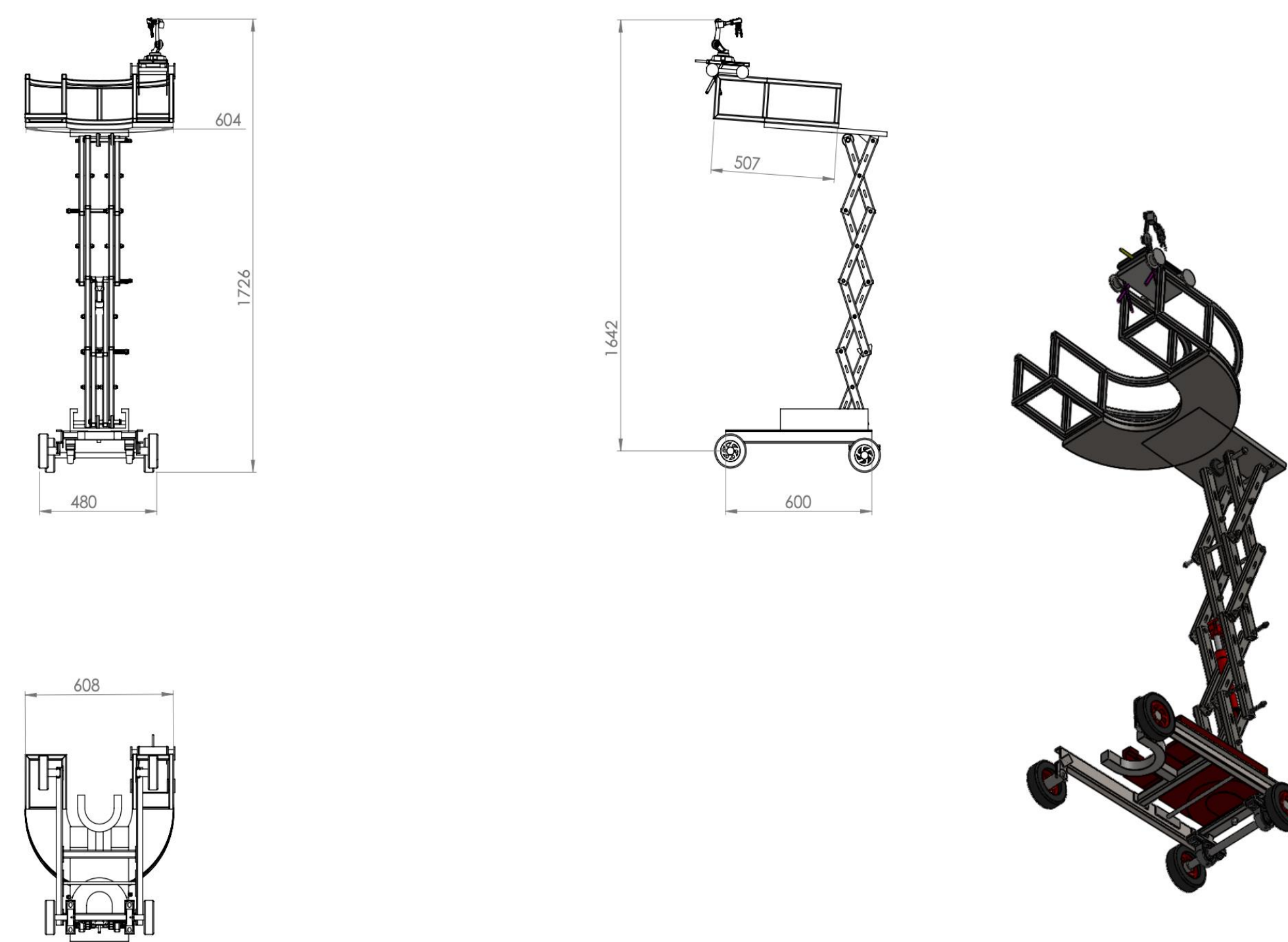
Muhammad Alsharief, Abdulmohsin Alqahtani, Fisal Altassan, Hamad AlNajrani
Coach: Dr. Mohammad Alam



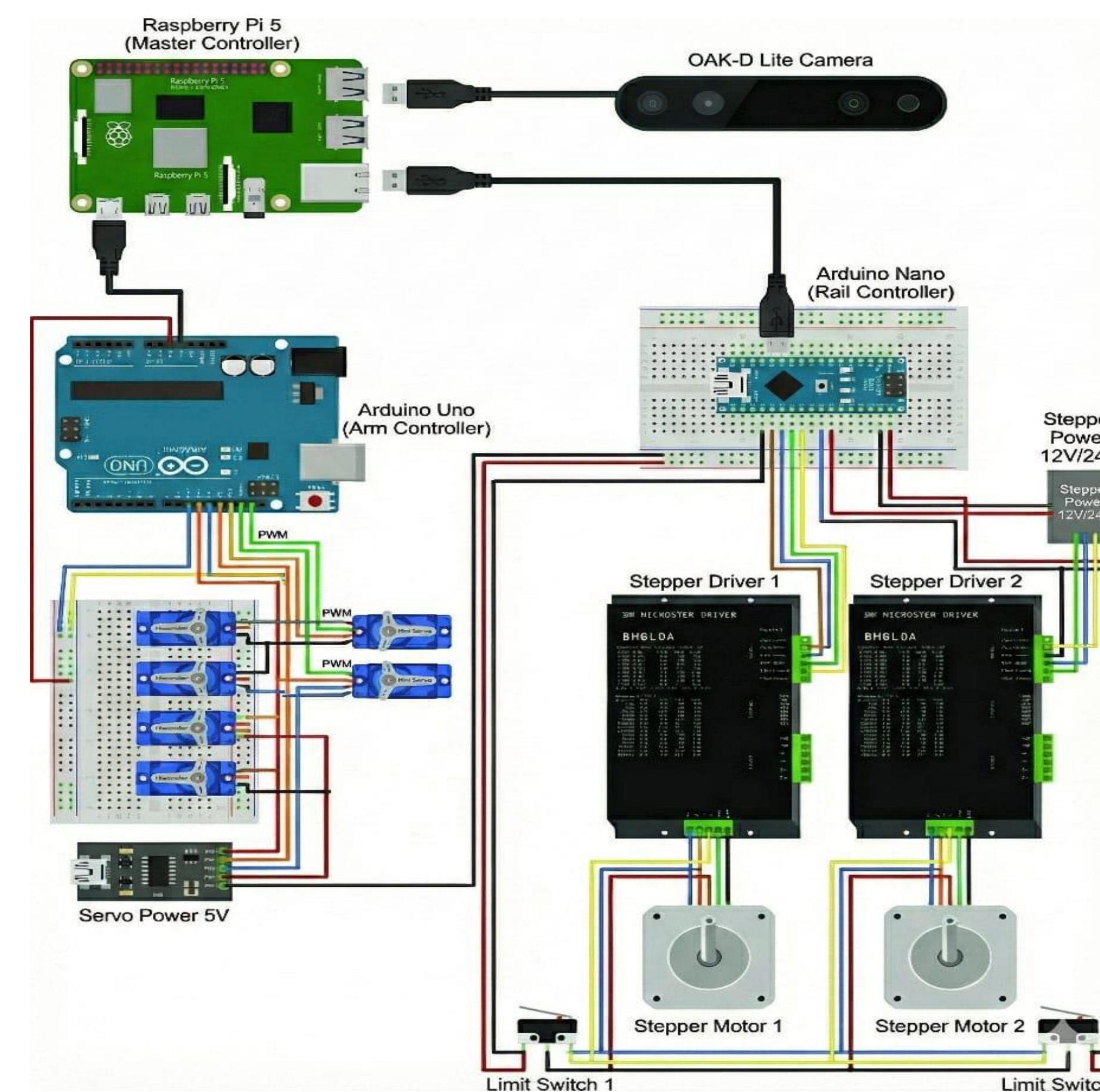
Problem Statement

Traditional date harvesting in Saudi Arabia requires workers to climb palm trees up to 15 meters tall using primitive tools, a method that is dangerous, slow, and labor-intensive. This approach leads to frequent injuries, high labor costs, and inconsistent productivity. As a result, there is a pressing need for a safer, more efficient, and technologically advanced solution to meet the rising demand while reducing human risk and improving fruit quality.

Design



Component Diagram



Constraints

- Operates on a 1.5 m palm mock-up; not intended for full-scale field harvest.
- Vision system must operate reliably under ≥ 100 lux lighting.
- Maximum incline traversal: $\leq 7^\circ$ slope.
- System must operate safely in 25 km/h sustained winds and 40 km/h gusts.

Our Solution

Our solution is a semi-autonomous ground robot designed to conform to the palm tree using a U-shaped net structure, detects date bunches with a depth camera and computer-vision pipeline, and performs the cutting process autonomously through a 5-DOF end-effector. By integrating vision-based detection, mechanical lifting, and robust control, the system improves safety, reduces human effort, and provides a reliable, low-cost alternative to manual harvesting.

Prototype



Testing



Step 1: Detection
Robot detects bunch then rail stops automatically.



Step 2: Alignment
Robot aligns itself for harvesting.



Step 3: Grasping
End-effector grasps the date bunch.



Step 4: Autonomous cutting
Autonomous cutting is performed successfully.

Specifications

- Minimum battery runtime: ≥ 4 hours.
- Remote-control range: ≥ 10 m.
- End-effector must provide 3 DOF for accurate branch positioning.
- Bunch-detection accuracy: $\geq 85\%$.
- Robot base height: 1.2–1.3 m; manipulator height: 0.7–0.8 m.
- Robot base footprint: $\leq 80 \times 80$ cm.
- Payload capacity: ≥ 5 kg.
- Robot driving speed: ≥ 1 m/s.
- Harvesting time: < 5 min per palm.
- Successful harvesting per palm: $\geq 80\%$
- Fruit damage rate: $< 5\%$ of harvested bunches.
- Robot must respond to user commands in ≤ 2 seconds.