

Evaluation and future prospects of the SHIVAA strawberry-picking robot

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Abstract— SHIVAA is a research prototype of a strawberry-picking robot. A series of field and laboratory tests was conducted to evaluate the system's performance. This video showcases key footage from these tests and highlights the main outcomes and shows future development potential.

The SHIVAA robot [1] was specifically designed for harvesting strawberries grown in outdoor environments. The system features a lightweight manipulator and a perception system based on multispectral camera images for strawberry detection and classification. A passive suspension mechanism ensures all-wheel contact with uneven open-field terrain.

A series of field tests was conducted during the 2024 and 2025 strawberry seasons on different professional strawberry plantations at various stages throughout the season. The aim was to evaluate the system's performance in picking strawberries and navigating within rows of plants. Performance parameters such as manipulation success rate, damage or bycatch rate, and total output were determined from the data acquired during the field and outdoor laboratory tests.

In addition to the field tests, opportunities to increase the operating speed of the system were identified. Video analysis revealed potential for optimizing high-level coordination, and laboratory tests determined the maximum manipulator speed. To obtain an initial limit value for maximum movement speed, optimal trajectory plans for the manipulator's upward and downward movements were generated using an iterative linear-quadratic regulator. Differential times of 0.8 seconds were feasible in laboratory experiments.

During normal operation, the system's individual capabilities are combined to create autonomous sequence control for the gripping process. Some sequential actions can also be performed in parallel to save time. For example, the manipulator can be moved to its rest position at the same time as moving to the next harvesting section. Additionally, the linear joint can be integrated into the manipulator control system, meaning it no longer needs to be controlled individually during harvesting or fruit placement.

Currently the robot is further developed to act within a hybrid team of human field workers and other robots to complete the field logistics.

Figure 1. SHIVAA robot in a strawberry field



TABLE I. EVALUATION RESULTS

Manipulation success rate (successfully picked strawberries/total attempts)	71 %
Harvest completeness (harvested strawberries/available strawberries)	57 %
Harvest completeness with double passes	81 %
Damage rate (damaged/total picked strawberries)	8 %
Bycatch rate (operations with bycatch / total strawberries picked)	8 %
Total output (kg / hour, at 25g/strawberry)	3,21 kg/h
Total output at 100% (kg/hour, at 25g/strawberry)	4,86 kg/h
<i>Theoretically achievable performance</i>	
1. Process optimization and increased manipulator speed.	10,70 kg/h
2. Like 1. with an additional 100% harvest rate.	15,15 kg/h
3. Like 2. with a second manipulator.	30,31 kg/h

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