Robotic Mechanical Harvester for Fresh Market Citrus: Automated Picking Hand

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The development of a Picker robot requires the development of a viable end effector (picking hand) for removing fruit from the trees. This project, co-funded by the CRB, Washington Tree Fruit Research Commission, Vision Robotics, and Olin College of Engineering, is intended to develop prototypes of the first generation picking hand for fresh fruit. The technical development is performed through the Senior Consulting Program for Engineering at the Olin.

The team studying orange trees. With them (in the windbreaker, second from left) is CRB Board Member Don Roark, chairman of the CRB postharvest committee.

The picking hand must gently remove each piece of fruit from a tree and deposit it into a conveyor system. It must hold fruit of different sizes and work delicately and reliably regardless of whether the fruit is hanging freely, leaning against or partially obstructed by other fruit, branches or leaves. Picking must be completed without damaging the harvested piece or other fruit near its line of motion.

**Status:** The team’s early tasks included brainstorming, sketches, quick models and field tests. A December visit to Visalia groves has augmented knowledge gained from photographs. The team is analyzing data from this visit for potential grasping and stem-cutting systems, which it will incorporate its findings into its designs in early 2008.

**Research, Brainstorming and Analysis:** The project began with a literature search to review existing ideas. In studying orange trees, the team found that oranges seldom lean against anything causing them to tilt more than 45 degrees from vertical. This predictable fruit orientation simplifies the picking task.
Brainstorming yielded many ideas that fell into a few general categories. The techniques for grasping the fruit include a tube, pouch, suction, flex fingers and joint fingers. Methods for removing include noose, jaws and single jaw. The various ideas were tested in Visalia and data collected for the design selection. The preliminary analysis indicates either a pouch or suction with a noose as the preferred combination. The most demanding requirements include: fast operation, cutting the stem as flush as possible, effectively picking a wide range of fruit sizes (Ø2” – Ø4”), and operating effectively in dense orange trees.

**Remaining Tasks:** In early 2008, the team will finalize the design direction, create a refined design and fabricate a prototype to be mounted on an industrial robot arm. The picking hand will be joystick controlled to pick the oranges and gently deposit them into a container representing the fruit handling system. Due to limited access to orange groves in Boston, the team is in the process of creating a test environment at Olin.

The ambitiousness of the project was understood from its conception, and the final goals have been scaled back as the full complexity became clear. Currently, the goal is to create a hand concept that demonstrates the potential to meet the goals such as effectiveness, speed, robustness and gentleness for picking most of the oranges on a tree. The final prototype likely will not work at speed, or have a design refined sufficiently to demonstrate robustness, economic viability or serviceability. Instead, engineers and other experienced parties should be able to recognize the potential for the concept to meet the goals. The design should serve as a viable starting point for the next design phase.

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