Robotic Fruit Picking End Effector

Olin College

VISION ROBOTICS Corporation

SCOPE
Senior Consulting Program for Engineering

Project Background & Challenge

Vision Robotics Corporation (VRC) has been working in agricultural applications since 2004. They are in the midst of developing a two-robot system that will harvest fresh tree fruit. The first robot, the Scout, identifies and locates all fruit on a given tree. The second robot then uses that information to actually harvest fruit. In taking on this challenging project, VRC is realizing a solution to the labor shortages that the fresh fruit market faces currently and will continue to face as immigration laws in the United States become more stringent.

As part of this endeavor,VRC charged this SCOPE team with developing the actual picking device, or end effector that will work as part of the fresh fruit harvesting robot. A number of different groups have been working on the automation of fruit harvesting since the 1960s, but as yet no commercially viable robotic solutions have been developed for the cosmetically sensitive fresh apple and orange markets.

Since the challenge of designing and fabricating a commercially viable solution for robotically harvesting fresh apples and oranges has never been solved, the team had the opportunity to think creatively and be on the forefront of innovation.

Project Goal

The team set out to design an end effector that represents a strong first step toward developing a commercially viable solution to robotically harvest apples and oranges. As such, the end effector must begin to deal with all of the design aspects listed below.

- Minimize damage to fruit that the end effector comes in contact with during harvesting operations
- Optimizable to reach speeds of ½ seconds per pick
- A life span on the order of millions of cycles
- Accommodation of fruit sizes of Ø2" to Ø4"
- Ability to pick fruit that is in clusters or obscured by twigs and leaves

Orchard & Grove Visits

Apples grow in clusters and hang off of the branch in any orientation.

Commerical apple trees are pruned aggressively and trained on wire supports for maximum apple production.

Oranges weigh down the tree branches.

Oranges mostly hang vertically down, but can grow in pairs.

Clippers are used to cut the orange stem flush with the top of the fruit.

The team investigates a young orange tree.

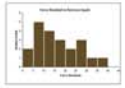
Preliminary Modeling & Testing

A successful pick!

How much force does it take to pick an apple?

Concepts are tested in the orange grove.

Orange stems can be sheared instead of cut.

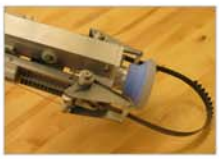


Fruit sizes range.

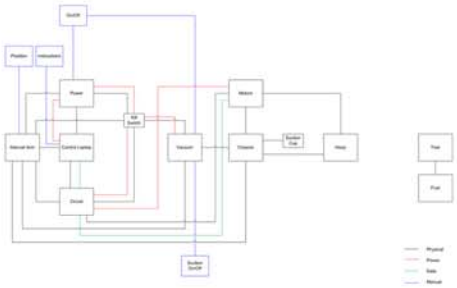
Concept Selection

The team used a selection matrix to determine which concept to develop more fully over the course of the second semester. A single hoop with a suction system was deemed to have the most potential.

Design Iterations



System Diagram



Design Details

Aluminum tubing acts as a backbone and conducts air for the suction system.

Cable drives reduce the end effector weight and overall size.

The slipery surface of the suction cup allows fruit to rotate and the stem to be isolated for cutting.

The flexible hoop varies diameter to contour around the fruit.

Return springs reduce the number of cables.

Future Work

Finish Proof of Concept

- Test current prototype in the field
- Pursue active cutting mechanism

Develop Production Model

- Optimize control algorithm
- Conduct manufacturability analysis
- Incorporate sensors into end effector
- Investigate other patentable concepts
- Design a fairing
- Design a vision system mount