NRI: INT: COLLAB: Tree Fruit Harvesting with Arrays of Vision-Guided Linear Robot Arms

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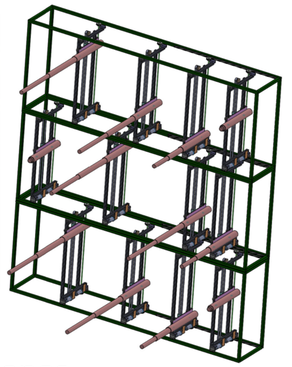
Introduction

- Labor scarcity and cost are driving the research and development of fruit harvesting robots.
- Existing robots are effective only when tree canopies offer high fruit visibility and reachability.
- Project goals: Design a multi-armed robot exhibiting high *picking efficiency* and *speed*, for a wide range of trees, a
  perform economic analysis of robotic fruit harvesting.



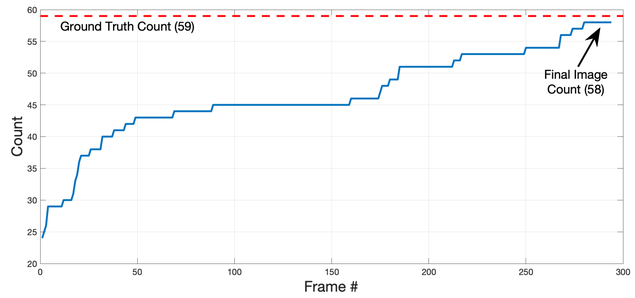


Technical Challenges

- Increase the visibility and detection of fruits in the presence of severe occlusions, which are characteristic of most real-world tree canopies.
- Maximize fruit harvesting speed, by scheduling and controlling the motions of multiple robot arms, in the presence of uncertainty in fruit perception.
- Model robotic harvesting economics, incorporating the coupled effects of picking efficiency and speed and number of robot arms.

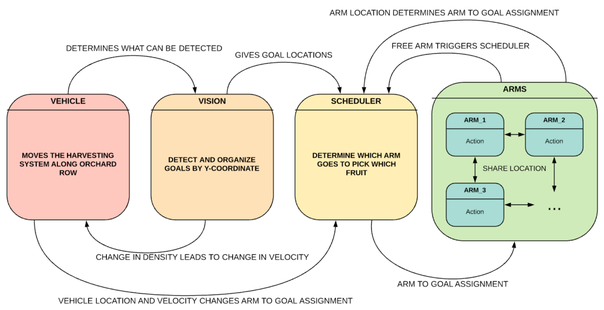
Scientific Impact

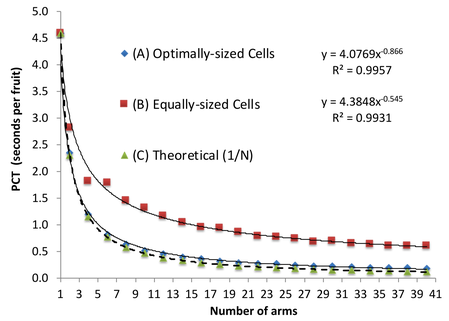
- Multi-camera 3D mapping and detection in dynamic scenes.
- Multi-agent coordination under uncertainty.



Approach and research thrusts

- Integration of air-induced foliage agitation with deep learning and multi-view, multi-frame imaging, for improved fruit detection.
- Real-time, dynamic near-optimal stochastic scheduling and collision-free control of multiple arms, for increased picking speed.





Broader Impact - Societal

- Increased competitiveness and sustainability for the fruit industry.
- Increased production of low-cost, high-quality fruits can lead to:
  - More, higher-paid operator jobs and increased labor demand at the postharvest stage.
  - Improved nutrition for consumers & low-income families.

Broader Impact - Educational

- Selected project activities will feed into undergraduate and graduate courses at UCD and CMU.
- Engagement of K-12 students:
  - UCD - Class presentations in Central Valley.
  - CMU - Girls of Steel Robotics Initiative.

Broader Impact Quantification

10-fold harvest speed increase.

More than 200 students/yr reached.

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