CPS: Small: Learning to Pick Fruit using Closed Loop Control and In-Hand Sensors

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Motivation: Fresh market tree fruit growers still rely on a large seasonal labor force for fruit harvesting. The availability of this workforce is increasingly uncertain, & robotics harvesters are not yet commercially available.

Challenge: Robotic fruit picking in the unstructured orchard is a challenging manipulation problem & seasonal constraints limit opportunities for data collection in the field.

Solution:

- Create an instrumented orchard proxy with realistic picking physics to serve as the training environment
- Use the proxy to design a multi-modal picking end-effector
- Use in-hand sensing & structured machine learning to train robot controllers to execute complex picking motions

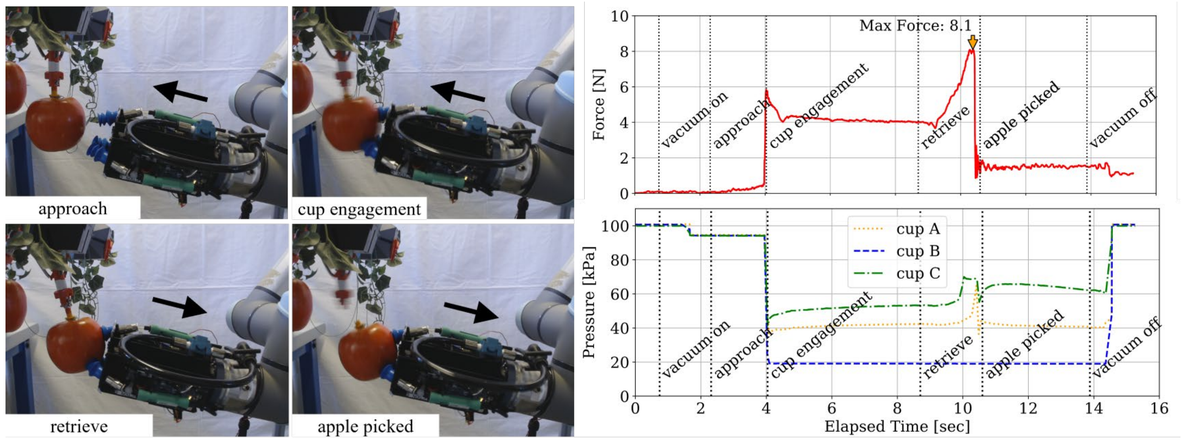

Figure 1. *Left*: Sequence of an apple-pick using the physical proxy. *Right*: (top) wrist net force and (bottom) suction cup pressure plots for the apple pick shown on the left.

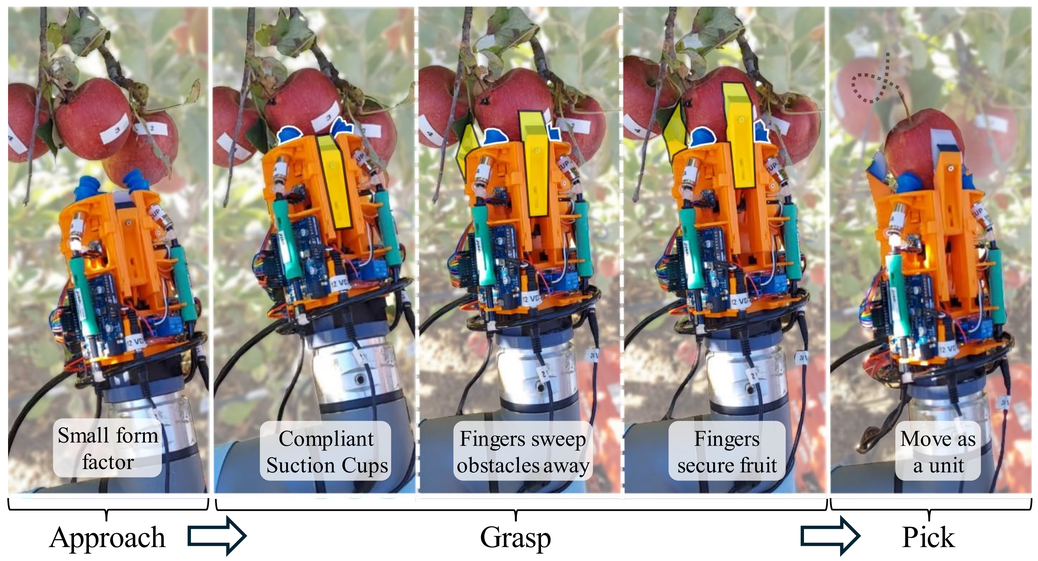

Figure 2. Robotic harvesting with the prototype at a commercial apple orchard.

Scientific Impact: A generalized framework for learning within a physical environment that bridges simulation & the real world

Broader Impact:

- A learning framework using in-hand sensing that can be generalized to other agricultural applications requiring physical manipulation
- Research experiences for 3 graduate students & 5 undergraduate students

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