A rapid prototyping design tool for pear harvest-aid platforms utilizing 3D fruit reachability and kinematic modeling

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Goal: Harvesting machine design tool

- Tree training system & orchard layout
- 3D fruit distributions
- Platform kinematics
- Worker kinematics & work practices
Mechanical pear harvesting

Four possibilities for pear picking

1. Branch hitting
   - Impractical for pears.

2. Limb shaking
   - Inefficient.
Mechanical pear harvesting

3. Trunk shaking
   ▣ Too much bruising.

What if fruits could decelerate somehow?
Design issues

- How many tines?
- What configuration?
- What sizes?
- Branch interference?
- Fruit drop distances?
- ...

- How can we evaluate different designs?

Mehlschau 1974
Mechanical pear harvesting

4. Robotic picking
   - Technical problems
   - Design / efficiency problems.
Design Issues

- Could actuator arrays achieve high picking efficiency and speed?
- How many arms?
- What configuration?
- What sizes/envelopes?
- How do branches interfere?
- ...
- How can we evaluate different designs?
Goal: Harvesting machine design tool

- Tree training system & orchard layout
- 3D fruit distributions
- Platform kinematics
- Worker kinematics & work practices
Year 2 of project; ends March 2014

Funding sources for 2013-14

Canning Peach Mechanization Research Fund

California Pear Advisory Board
Methodology
Data collection

- 7/24/13: Joe Green Ranch, Courtland
  - Trees: Open-vase, ~33 yrs old; Bosc.
- 8/12/13: Dan Family Ranch, Lakeport
  - Trees: Hedged, ~12 yrs old; Red Bartlett.
- 8/13/13: Ruddick Ranch, Ukiah
  - Trees: Open-vase, ~ 15 yrs; Yellow Bartlett.
- 8/14/13: Ruddick Ranch, Ukiah
  - Trees: High Density Trellis, ~ 3 yrs; Yellow Bartlett.
DATE: 7/24/2013
WHAT: Pear trees, standard open-vase
AGE: ~33 yrs
TREE HEIGHT: ~14ft
VARIETY: Bosc
Joe Green Ranch

DATE: 7/24/2013
WHAT: Pear trees, standard open-vase
AGE: ~33 yrs
TREE HEIGHT: ~14 ft
VARIETY: Bosc
WHERE: Joe Green Ranch

<table>
<thead>
<tr>
<th>Tree Index</th>
<th>Number of Fruits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1600</td>
</tr>
<tr>
<td>2</td>
<td>500</td>
</tr>
<tr>
<td>3</td>
<td>1400</td>
</tr>
</tbody>
</table>

The graph shows the number of fruits per tree index, with Tree Index 1 having the highest number of fruits.
Joe Green Ranch

DATE: 7/24/2013
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Radial distance of fruits from trunk
DATE: 7/24/2013
WHAT: Pear trees, standard open-vase
AGE: ~33 yrs
TREE HEIGHT: ~14 ft
VARIETY: Bosc
WHERE: Joe Green Ranch

4000 mm = 13.1 ft
DATE: 8/12/2013
WHAT: Pear trees, Trellis
AGE: ~12 yrs
TREE HEIGHT: ~16ft
VARIETY: Bartlett
Dan Family Ranch

DATE: 8/12/2013
WHAT: Pear trees, Hedged
AGE: ~12 yrs
TREE HEIGHT: ~16ft
VARIETY: Bartlett
DATE: 8/12/2013
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Dan Family Ranch

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TREE HEIGHT: ~16ft
VARIETY: Bartlett
DATE: 8/12/2013
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AGE: ~12 yrs
TREE HEIGHT: ~16ft
VARIETY: Bartlett

Distance of fruits from tree-row
Ruddick Ranch, Ukiah

DATE: 8/13/2013
WHAT: Pear trees, standard open-vase
AGE: ~15 yrs
TREE HEIGHT: ~13.5 ft
VARIETY: Bartlett
DATE: 8/13/2013
WHAT: Pear trees, standard open-vase
AGE: ~15 yrs
TREE HEIGHT: ~13.5 ft
VARIETY: Bartlett
Ruddick Ranch

DATE: 8/13/2013
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Ruddick Ranch

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WHAT: Pear trees, standard open-vase
AGE: ~15 yrs
TREE HEIGHT: ~13.5 ft
VARIETY: Bartlett

Radial distance of fruits from trunk
Ruddick Ranch

DATE: 8/13/2013
WHAT: Pear trees, standard open-vase
AGE: ~15 yrs
TREE HEIGHT: ~13.5ft
VARIETY: Bartlett

4000 mm = 13.1 ft
Ruddick Ranch

DATE: 8/14/2013
WHAT: Pear trees, High Density Trellis
AGE: ~ 3 yrs
TREE HEIGHT: ~9 ft
VARIETY: Bartlett
DATE: 8/14/2013
WHAT: Pear trees, High Density Trellis
AGE: ~ 3 yrs
TREE HEIGHT: ~9ft
VARIETY: Bartlett

Ruddick Ranch
DATE: 8/14/2013  
WHAT: Pear trees, High Density Trellis  
AGE: ~ 3 yrs  
TREE HEIGHT: ~9ft  
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Ruddick Ranch
Work in progress

Tree training system & orchard layout

3D fruit distributions

Platform/machine kinematics

Design tool

Worker kinematics & work practices
THANK YOU!

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