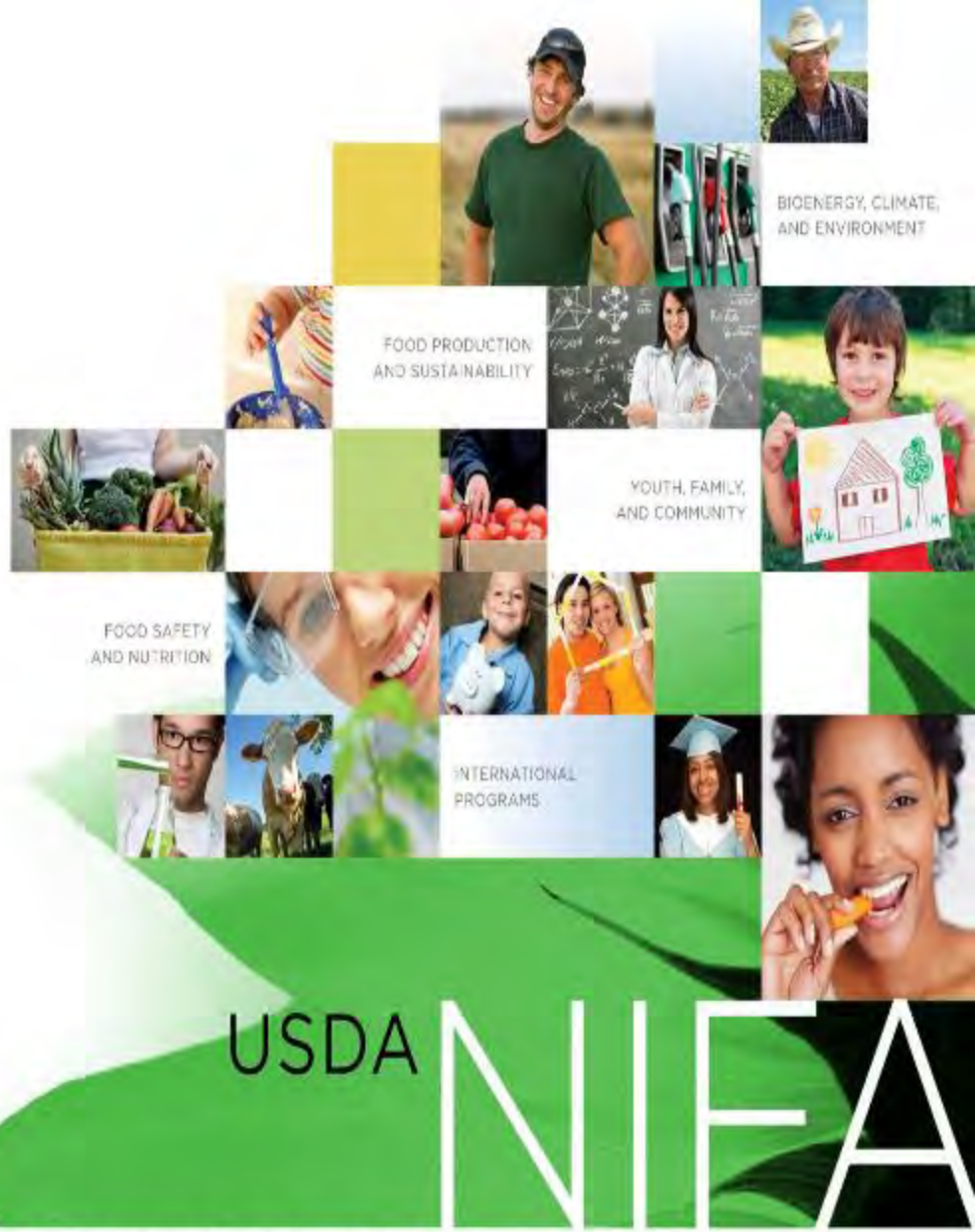
USDA United States Department of Agriculture | National Institute of Food and Agriculture | www.nifa.usda.gov @USDA_NIFA

NIFA's efforts supporting farmer/rancher health and safety through assistive technologies and robotics



March 21, 2018

Five Project Examples funded by NIFA/NSF National Robotics Initiative

- These are research projects (may have outreach components)
- Another program (SBIR) funds small business research grants

1. Robotic Harvest-Aiding Orchard Platforms: Stavros G. Vougioukas, UC Davis
2. Human Detection and Tracking for Agricultural Workforce Safety: Herman Herman, Carnegie Mellon University
3. FRAIL-BOTS: Fragile Crop Harvest-Aiding Mobile Robots (Strawberry harvest robotics): Stavros G. Vougioukas, UC Davis
4. Intelligent In-Orchard Bin Managing System for Tree Fruit Production: Qin Zhang, Washington State University
5. Machine Vision Robotic Systems for Automated Disassembling Crab Complex Compartments and Extracting Meats: Yang Tao, University of Maryland

Robotic Harvest-Aiding Orchard Platforms: Stavros G. Vougioukas, UC Davis

- Fresh–market tree fruits are hand-picked using ladders & bags.
- A very labor-intensive, risky and inefficient process.
- Farm labor shortage accentuates the problem.

- Harvest-assist machines on market eliminate ladders and walking
- One version was funded by USDA NIFA SBIR

Problem: Platform Efficiency

- 4-6 people pick at fixed heights; zone harvesting.
- Yield is non-uniform and picker speeds vary.

  ➔Machine harvesting throughput is limited by ‘slowest’ picker.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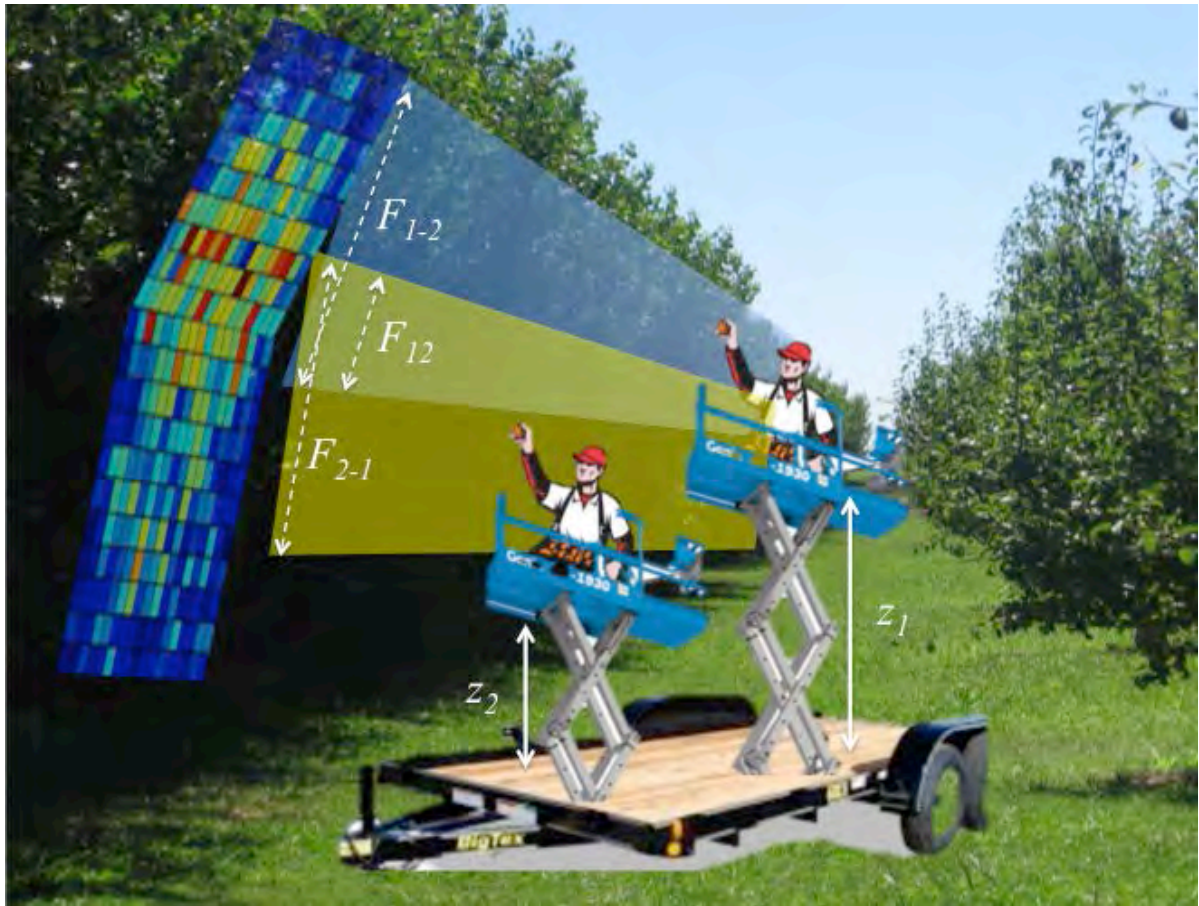
GOAL: Maximize machine harvesting throughput.

❑APPROACH:

- ➢Estimate ‘incoming’ fruit distribution and individual picker harvesting speeds.

Control platform speed & individual picker elevation.

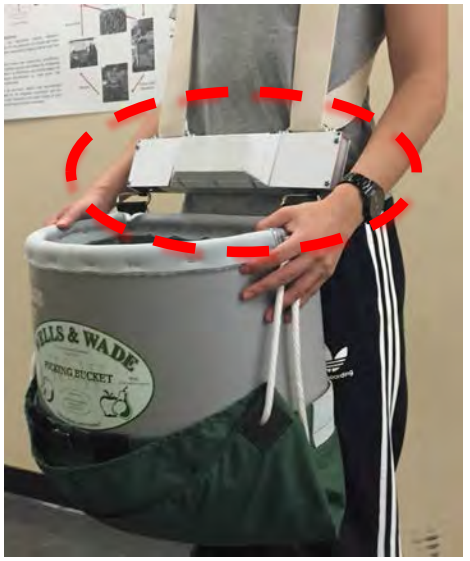


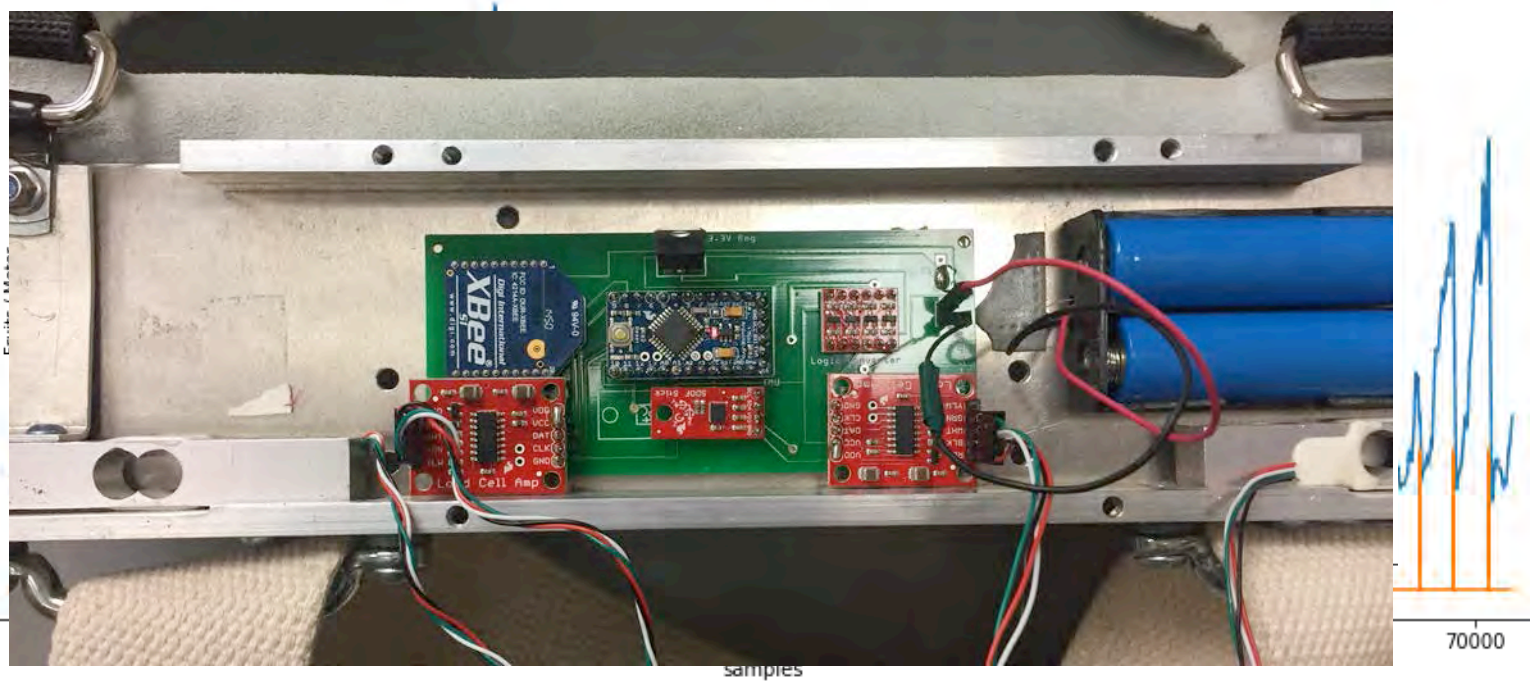
UC Davis: Platform retrofit

- Built individual picker lifts; control using hydraulic cylinders.
- Platform speed control.

UC Davis: Picking rate sensing

- Instrumented a commercial picking bag.
- Real-time monitoring of picking.
  - ➔Fruits picked per meter per pic'ker

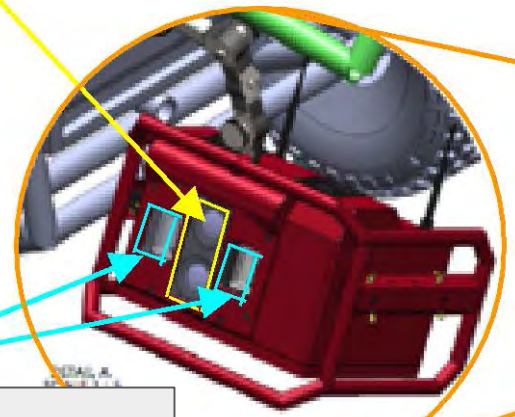




Agricultural Imaging Unit

Stereo Machine Vision Cameras

- 12MPixel
- 160,000 images per 12 hours



Imaging Unit mounted on harvest-assist platform.

Strobe Flashes

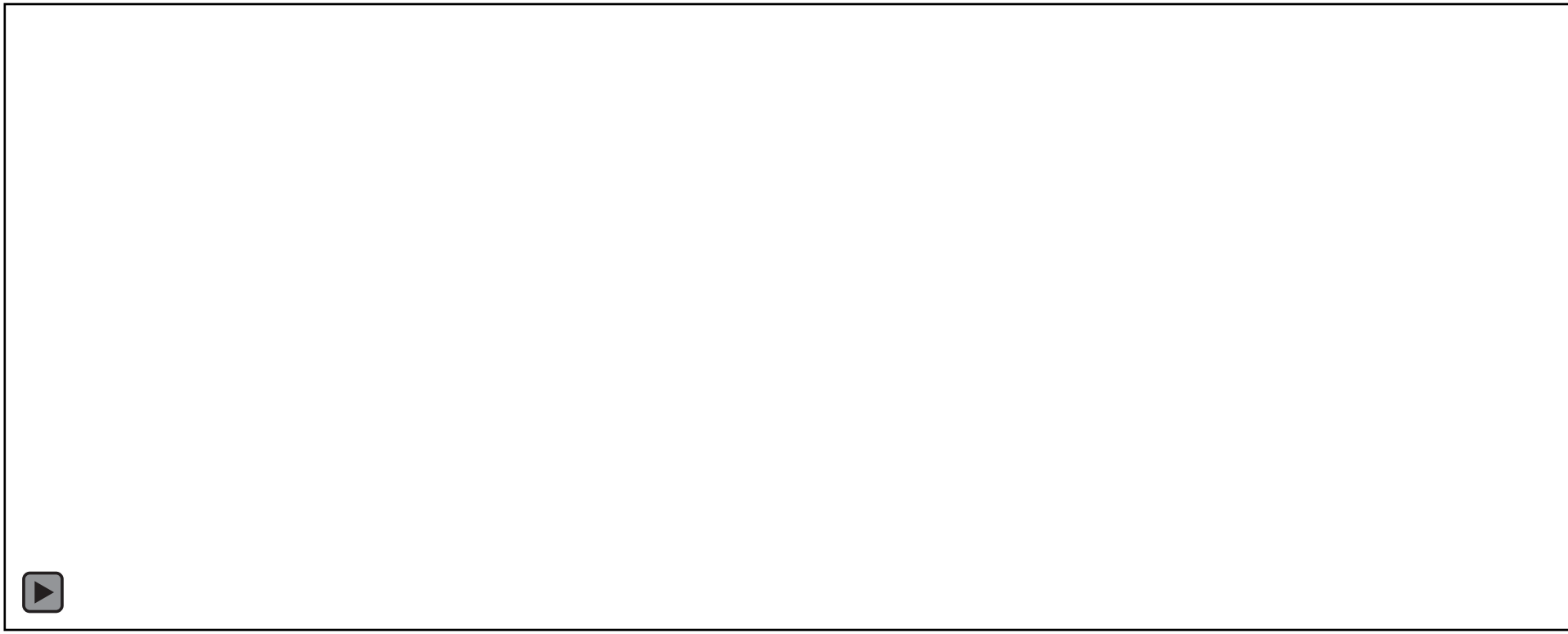
- Eliminate Sunlight Effects
- 2 Xenon Flashlamps

Apple Orchard Experiments

- Harvested in 2016, 2017.

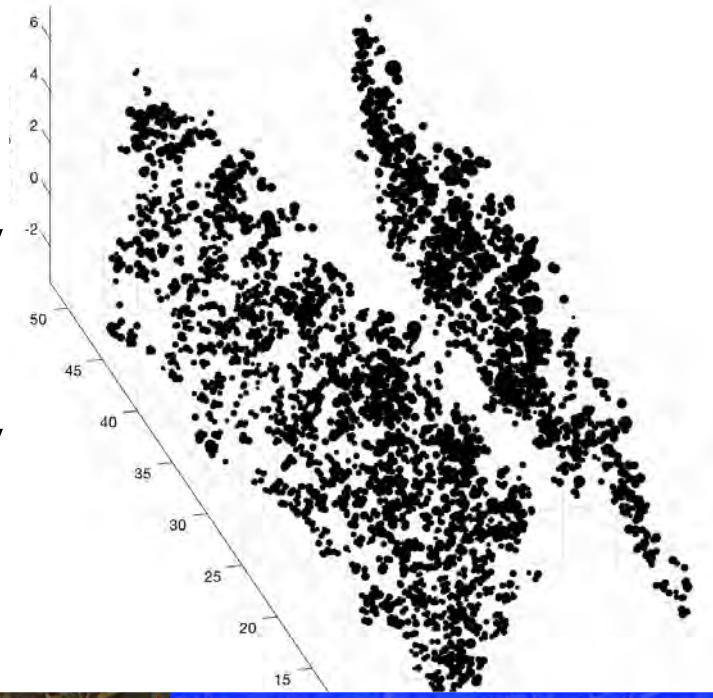
Apple Orchard Experiments

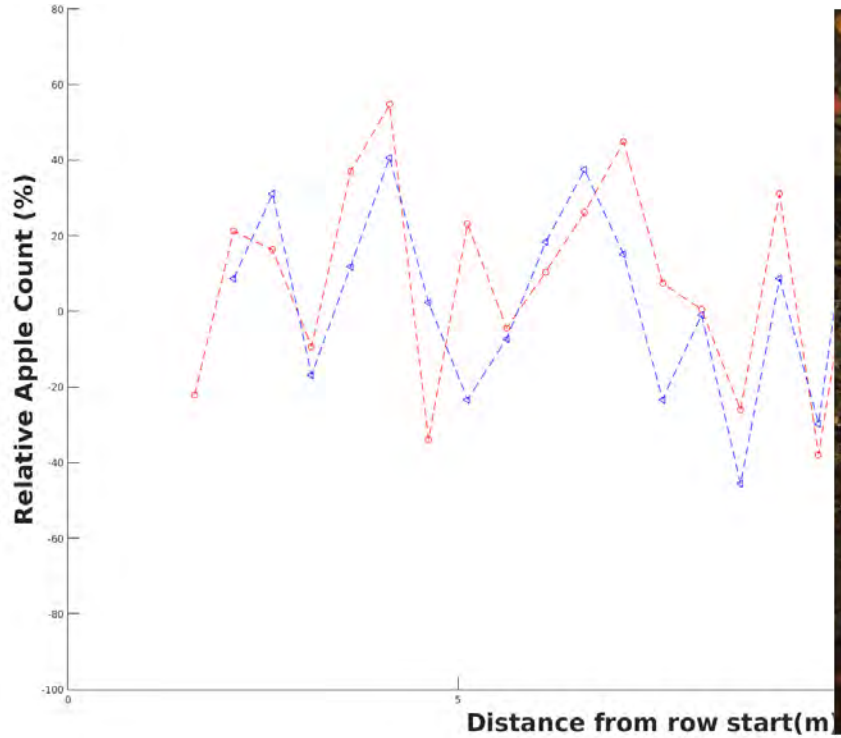
Camera estimated incoming fruit locations.

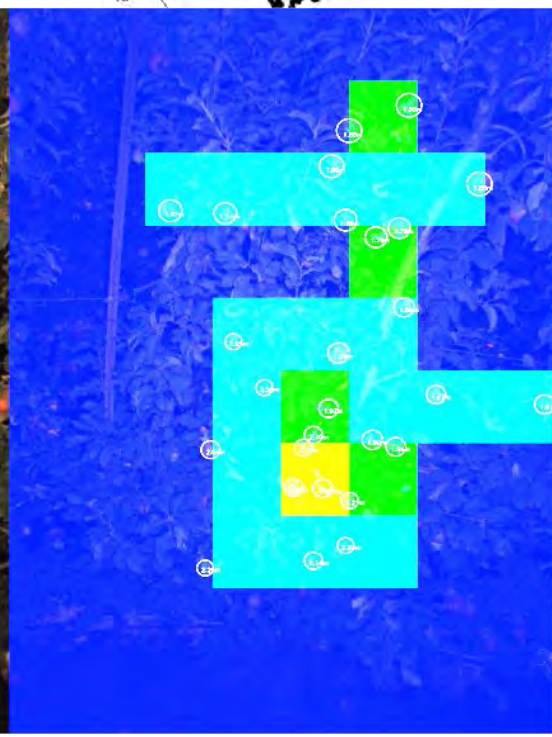


Fruit density estimation

- 2016: Camera vs. manually counted 4,000 apples; R^2=0.6
- 2017: Camera vs. bag & manually counted 3,000 apples; R^2=0.67
- Generated fruit density map.

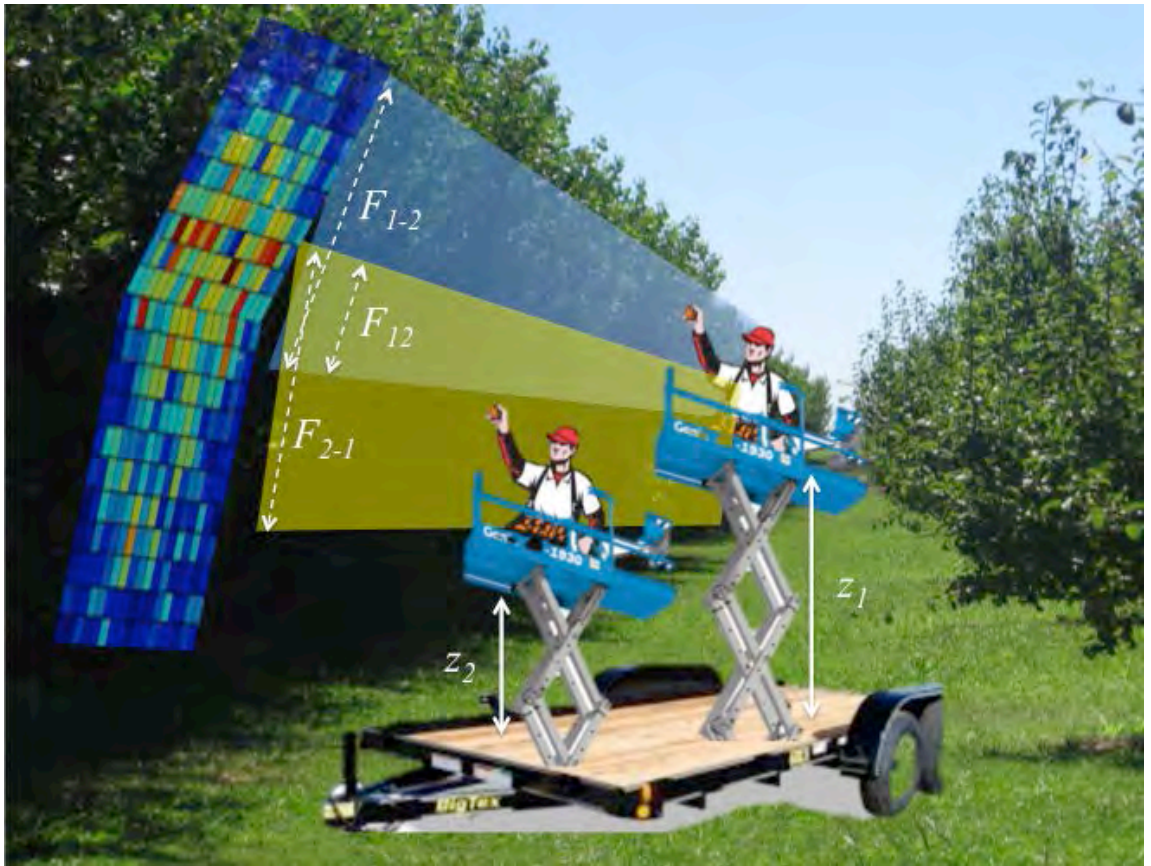




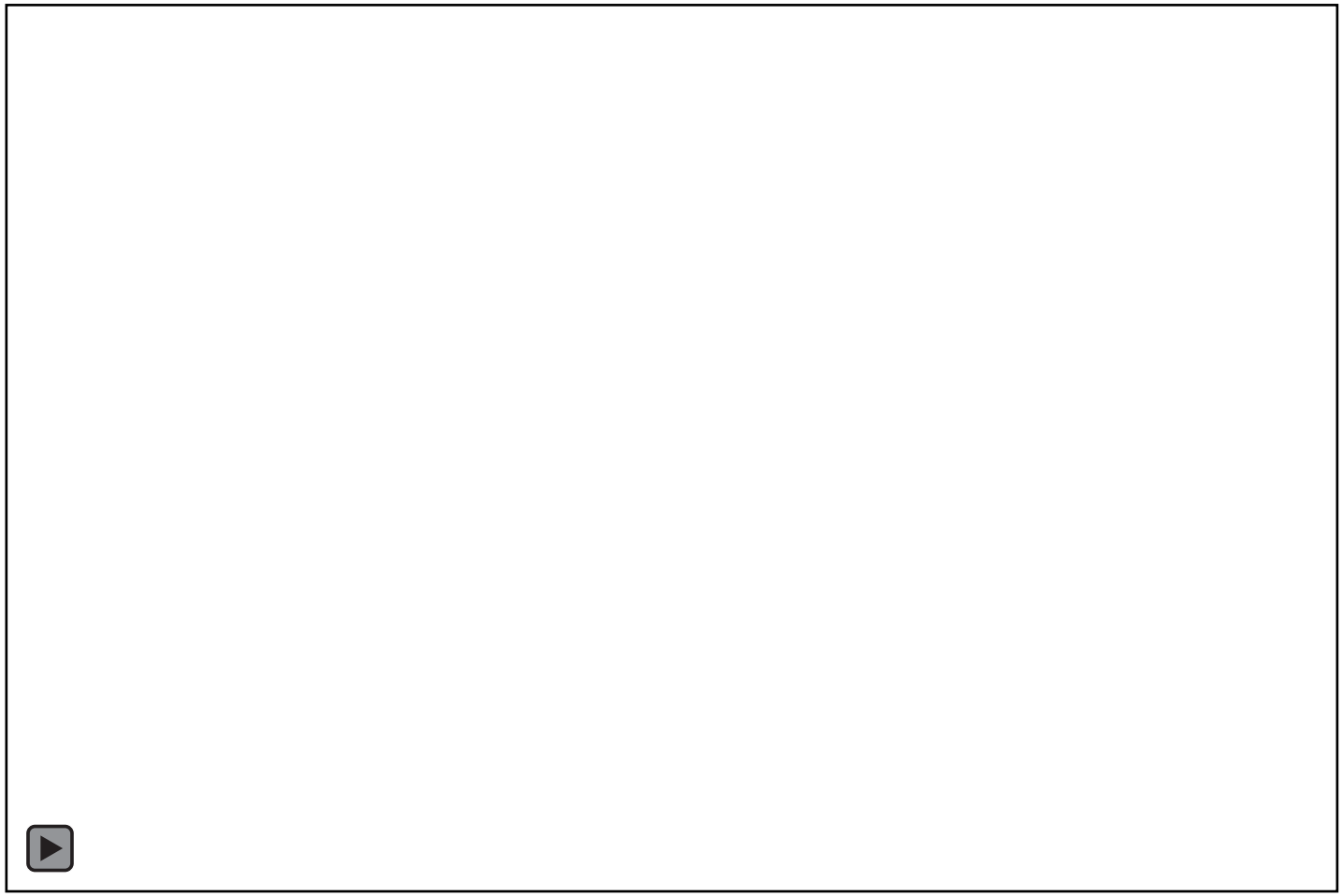


Current efforts

- Improve load-balancing
- Harvesting experiments: assess efficiency gains & picker acceptance.



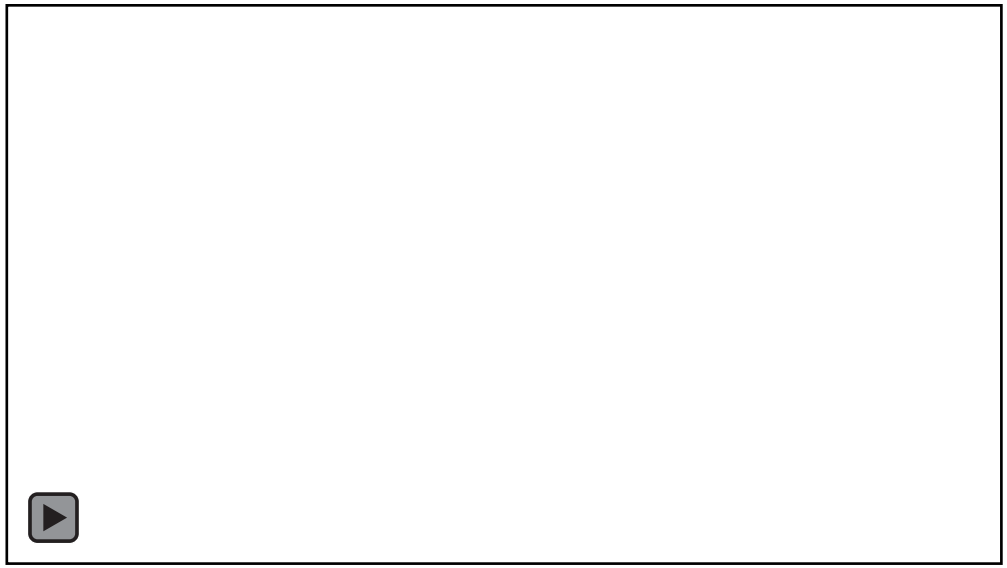
Human Detection and Tracking for Agricultural Workforce Safety: Herman Herman, Carnegie Mellon University



FRAIL-BOTS: Fragile Crop Harvest-Aiding Mobile Robots (Strawberry harvest robotics): Stavros G. Vougioukas, UC Davis

Inexpensive, relatively small, harvest-aiding robots

- Reduces harvesting time by transporting hand-picked crops
- Protects worker health by reducing slipping accidents

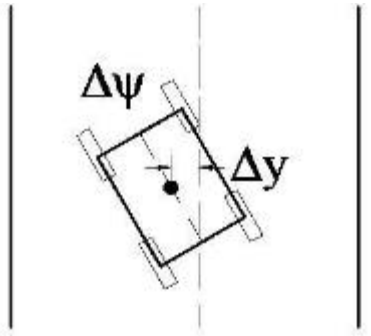


Video courtesy of Dr. Stavros Vougioukas, University of California Davis

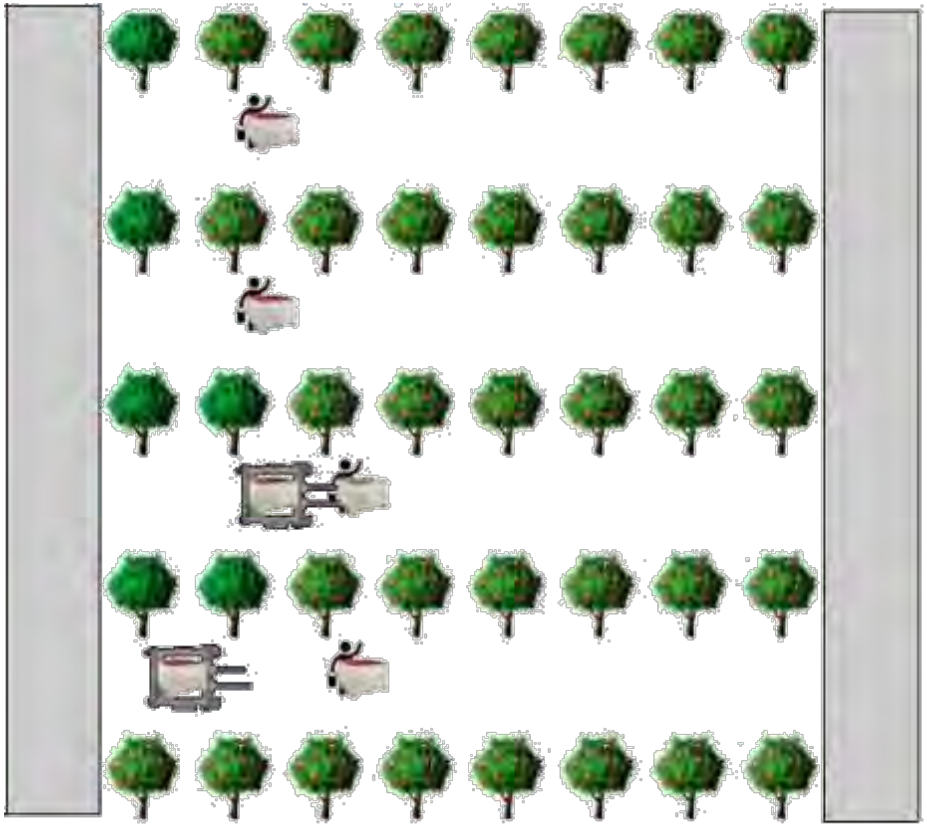
Intelligent In-Orchard Bin Managing System for Tree Fruit Production: Qin Zhang, Washington State University

- Developed multi-robot system to assist human workers in placing and moving bins in the orchard to allow for efficient harvest
- Designed for conventional picking

Autonomous bin-managing system to assist harvest in orchards.

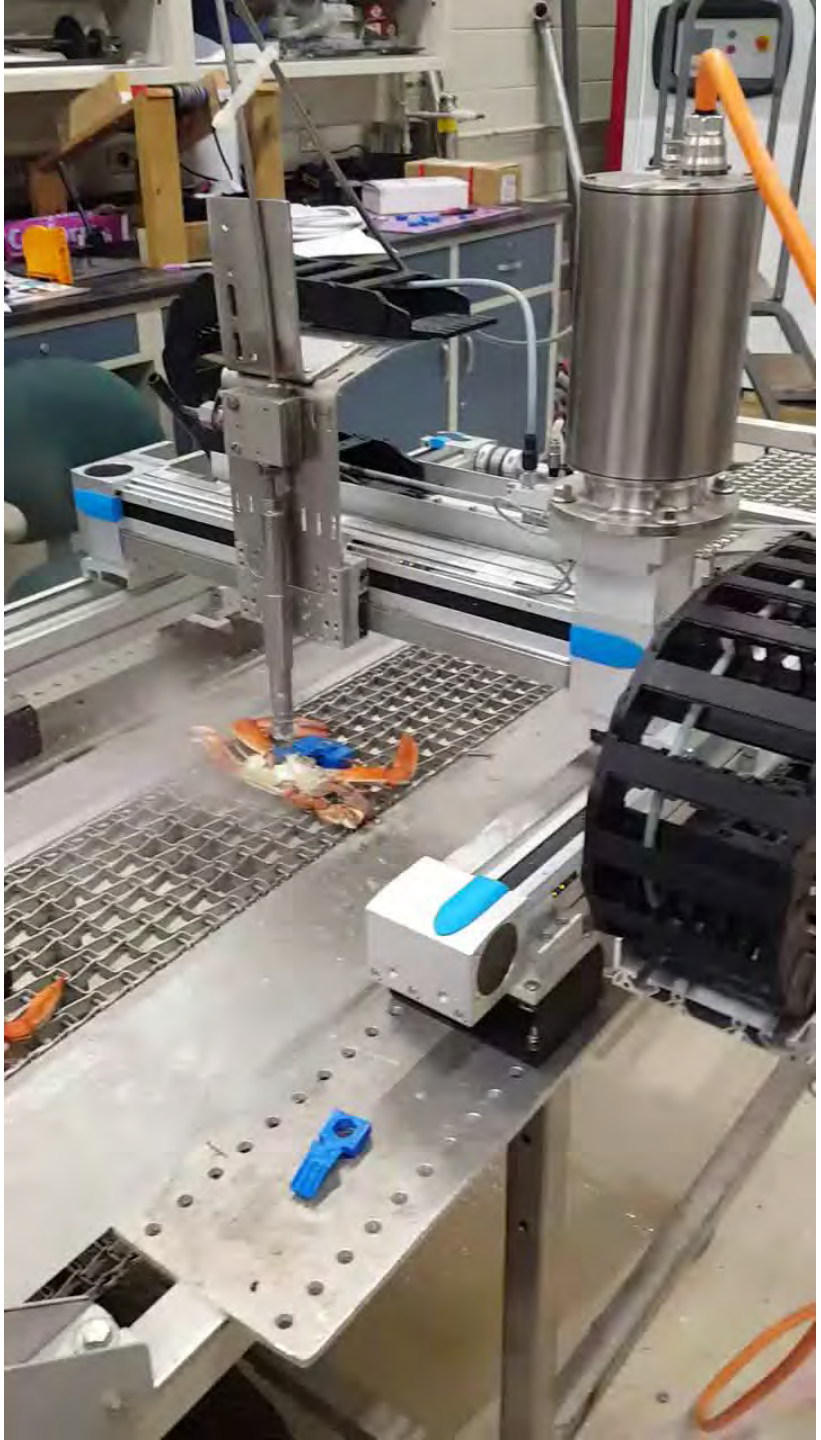


Simulation to optimize bin movement and placement



Layout of the orchard environment in the simulation

Machine Vision Robotic Systems for Automated Disassembling Crab Complex Compartments and Extracting Meats: Yang Tao, University of Maryland



To find more projects

- Google USDA CRIS
- Use Assisted Search

Thank You!

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