Mechanical Harvesting of Pistachio Trees: An Update

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Statewide Pistachio Day 2024

January 17th, 2024

Agenda

1. Challenges of harvesting mature trees
2. Smart harvesting system with adaptive shaking
3. Yield monitoring

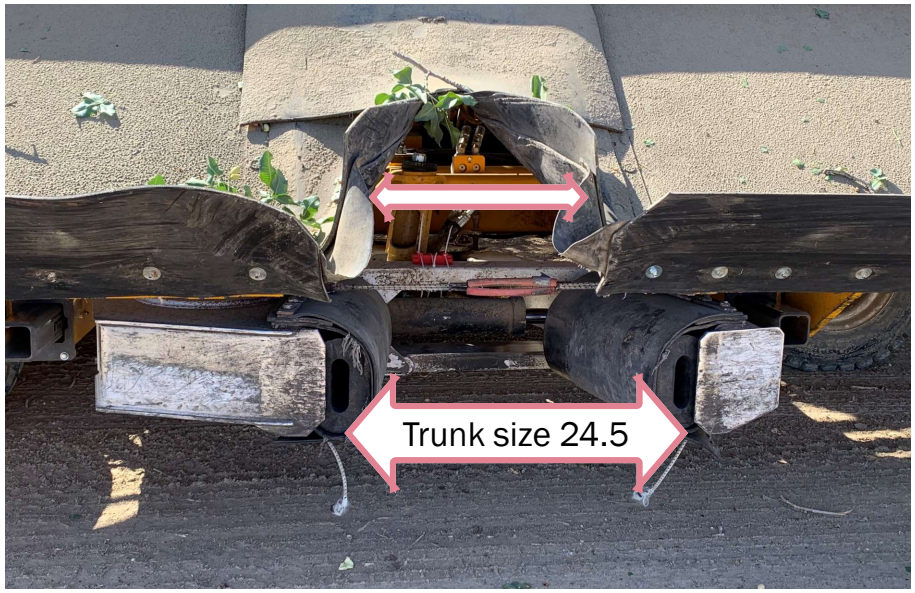
1- Challenges of Harvesting Mature Pistachio Trees

Harvesting mature trees with large trunks presents unique challenges, including the need for modification in tree trunk size and mechanical harvesting machines.

Challenges of Harvesting Mature Pistachio Trees

- Mr. Gary Schmidt's Orchard
- Madera, CA
- Kerman on Atlantica Rootstock
- Planted in 1968 (56 Years old trees)

Challenges of Harvesting Mature Pistachio Trees



Reducing Trunk Size

Reducing Trunk Size

Reducing Trunk Size

Summary

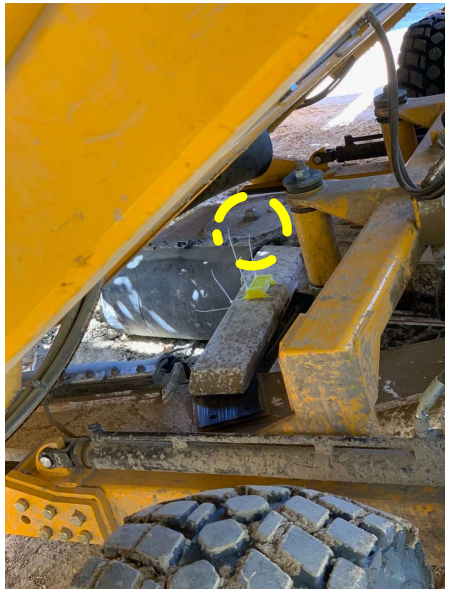
- Harvesting mature trees requires some modifications in harvesting machines
  - Shaker head
  - Catch frame
- The effects of cutting the trunk on tree health and yield are not clear yet.
- Modifying trunk dimensions might help to improve the efficiency of fruit removal.
- At what age should a pistachio tree be replaced?

2- Smart Harvesting System with Adoptive Shaking

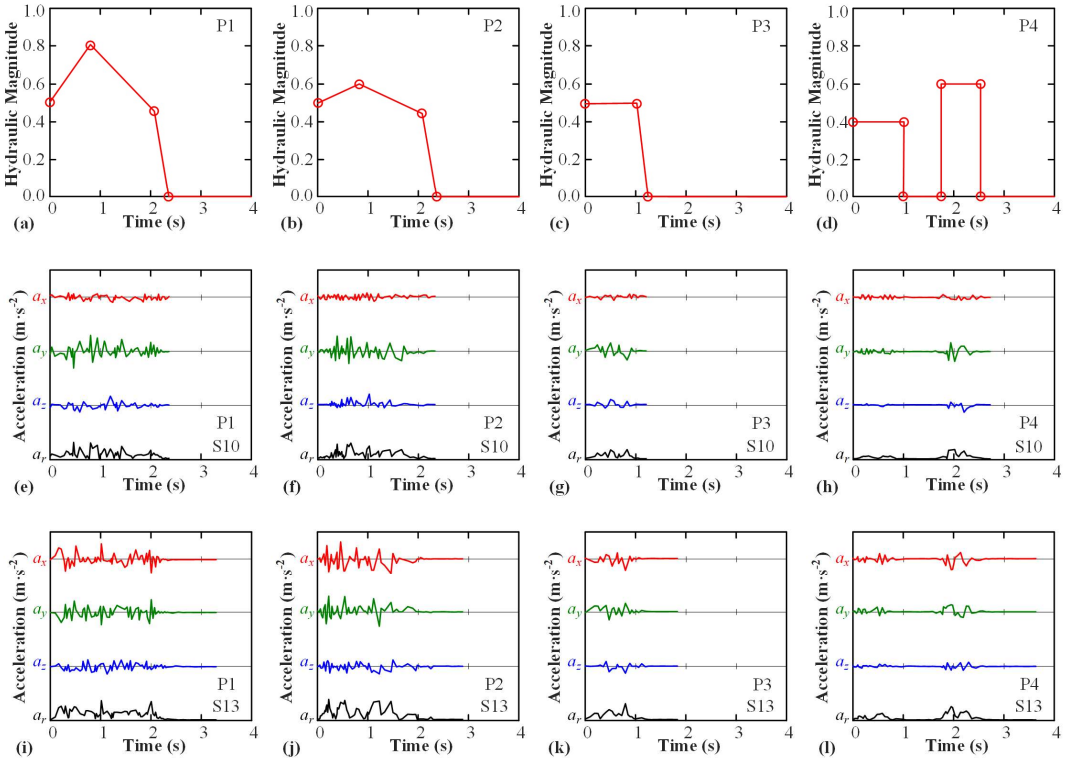
- Similar to very first shakers developed in 1970s.
- Literature suggests shaking frequency of 15-25 Hz and amplitude of 40–60 mm

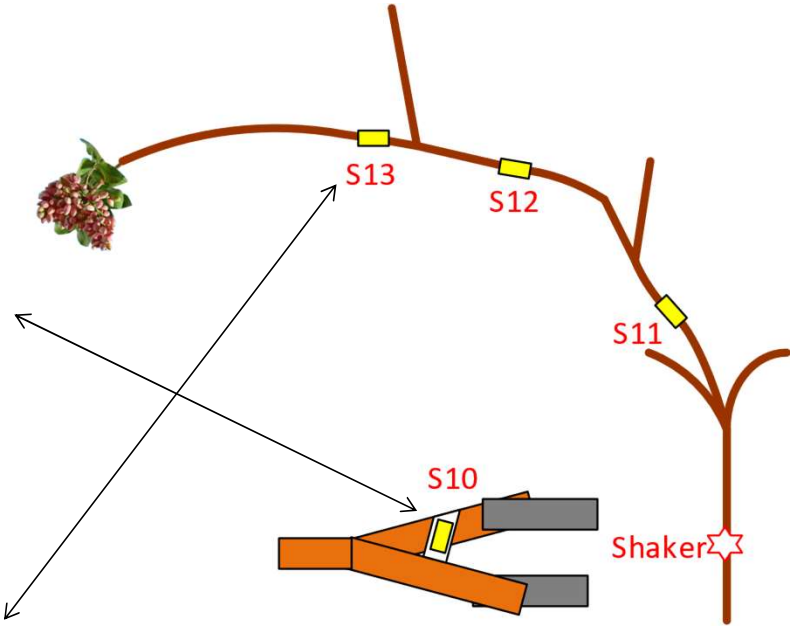
Field Tests

- Conducted field tests to measure acceleration in a tree during shaking using the wireless sensor system.



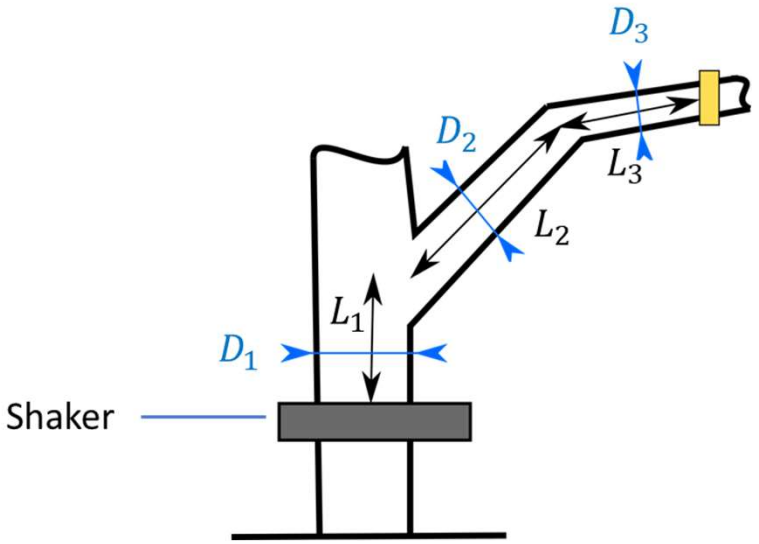
Tree Response to Four Shaking Patterns





Findings

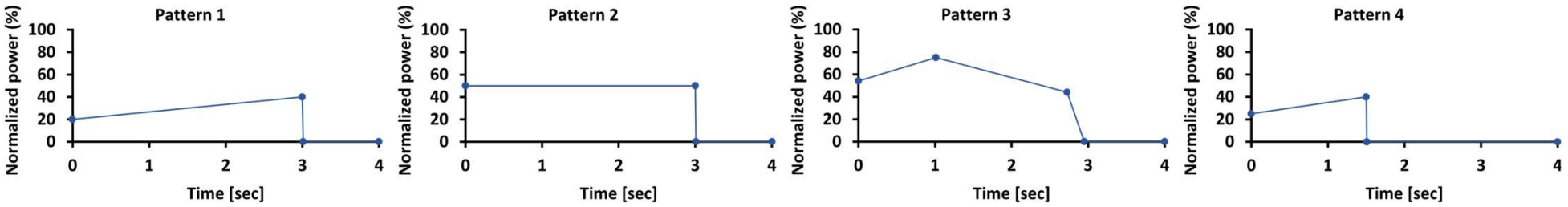
- The characterizations showed that larger pistachio trees need more energy for an effective harvest.
- In all cases, the maximum acceleration in tree structure was measured in the middle of the tree canopy.
- A trunk shaker may not be the most efficient method for pistachio harvesting.



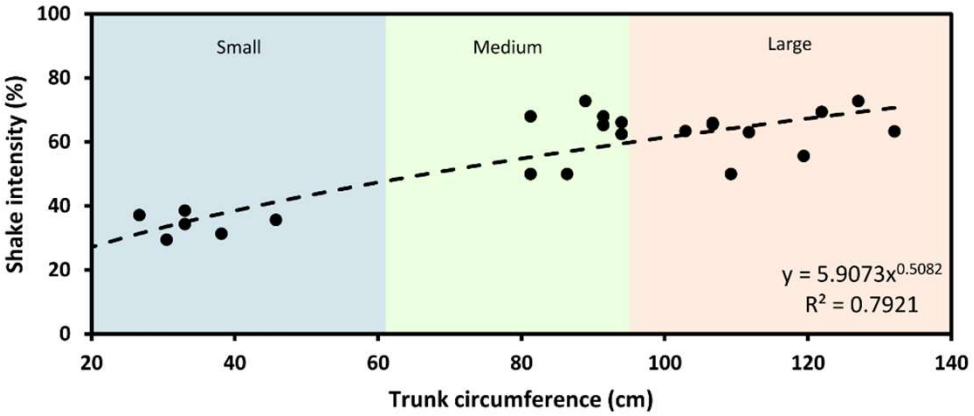
Experimental Procedure

- Pistachio orchards
- Date: September 2019
- Sample size: 30 trees

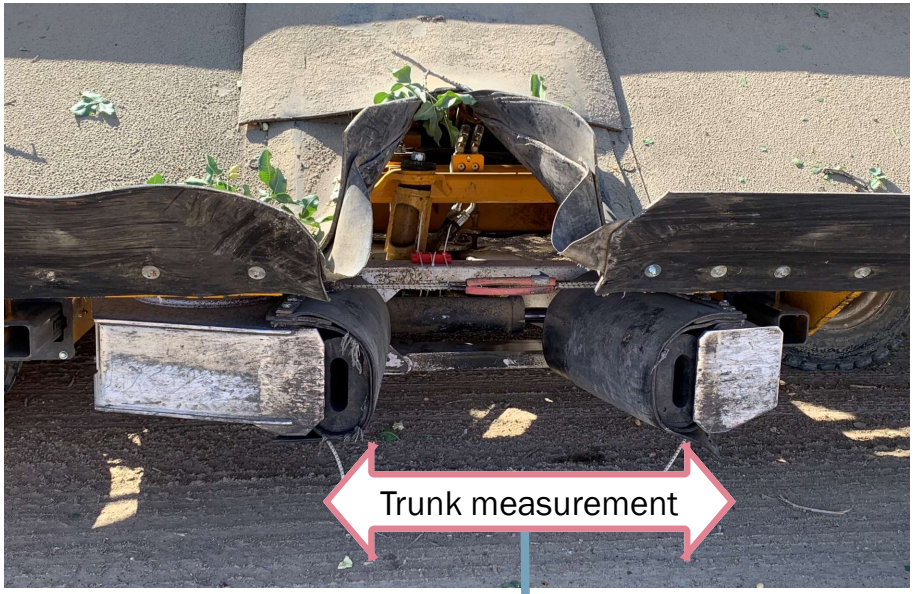
	Small	Medium	Large
Circumference	< 63 cm	63 – 95 cm	> 95 cm
Equivalent Diameter	< 20 cm	20 – 30 cm	> 30 cm
Shake 1	Pattern 4	Pattern 1	Pattern 1
Shake 2	Pattern 4	Pattern 1	Pattern 1
Shake 3	———	Pattern 2	Pattern 2
Shake 4	———	Pattern 3	Pattern 3



Vibration Analysis



Best shaking intensity vs. tree circumference



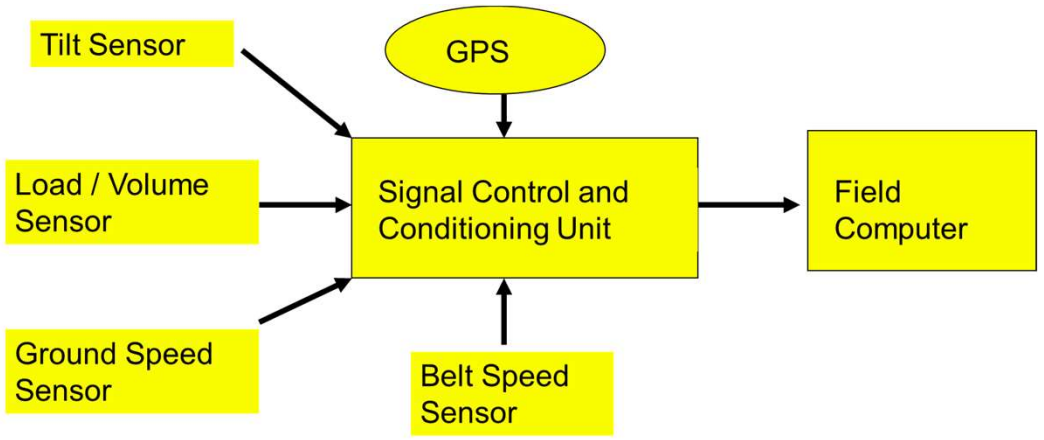
3- Yield Monitoring System for Pistachio Harvesting Machines

Yield monitoring is a process of quantifying yield per tree and provides real-time data on tree crop performance, allowing growers optimizing agricultural practices and enhancing overall efficiency.

Data-Driven Decision-Making: The development of yield monitoring systems for tree crops facilitates data-driven decision-making.

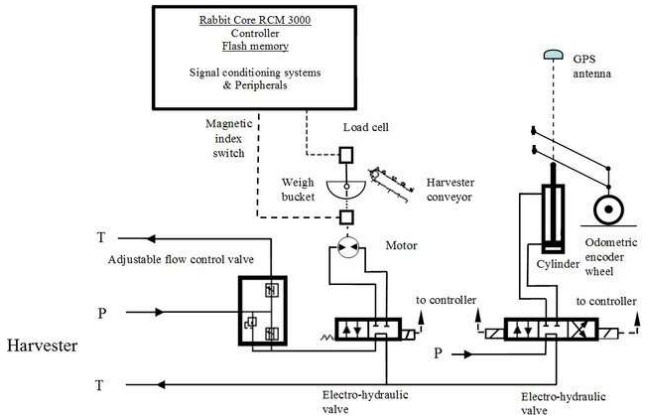
Quantifying in-Field Variability: Yield monitoring helps identify and understand in-field variability within a cropping system.

- Yield (mass/unit area)
- Location



Previous Research Projects

https://wcngg.com/2021/11/04/new-off-ground-harvest-research-incorporates-precision-yield-monitoring-for-improved-orchard-management/



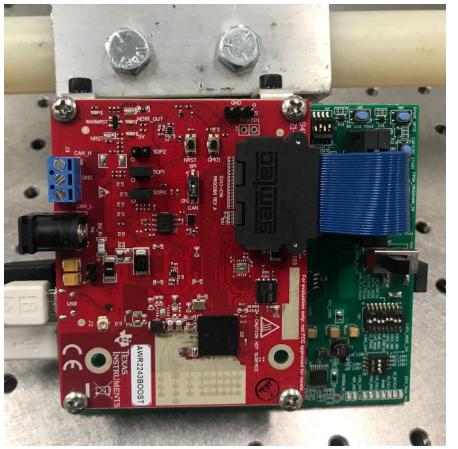
(Rosa et al., 2011).

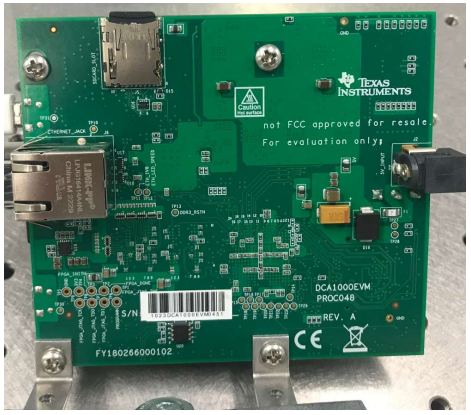
Advanced Millimeter-Wave Sensing

Millimeter-wave sensing refers to the use of millimeter-wave radar technology for various sensing applications. It is typically in the range of 30 to 300 Gigahertz.

Applications:

- Human Gesture Detection
- Obstacle Detection
- Security Systems
- Distance, Velocity, and Angle Measurement





Advanced Millimeter-Wave Sensing

Pros:

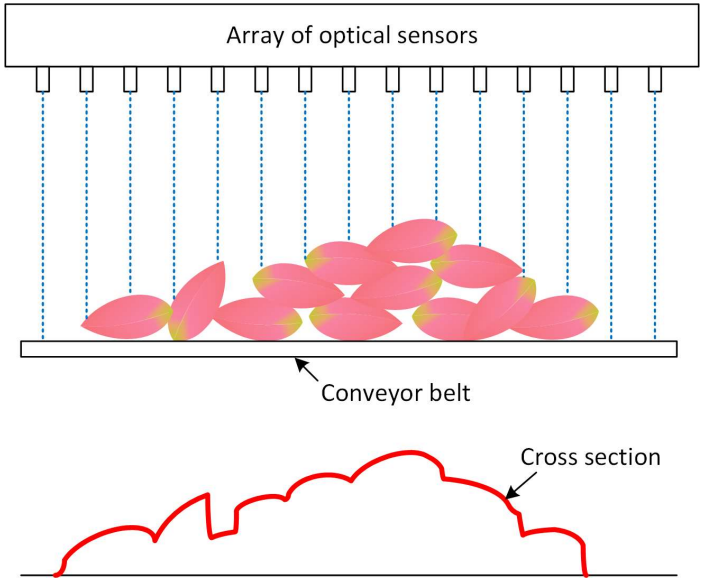
- New technology
- Non-contact
- Electronic components are available
- Advanced bandpass filter and syntheses system
- Data logger to record signals on the computer

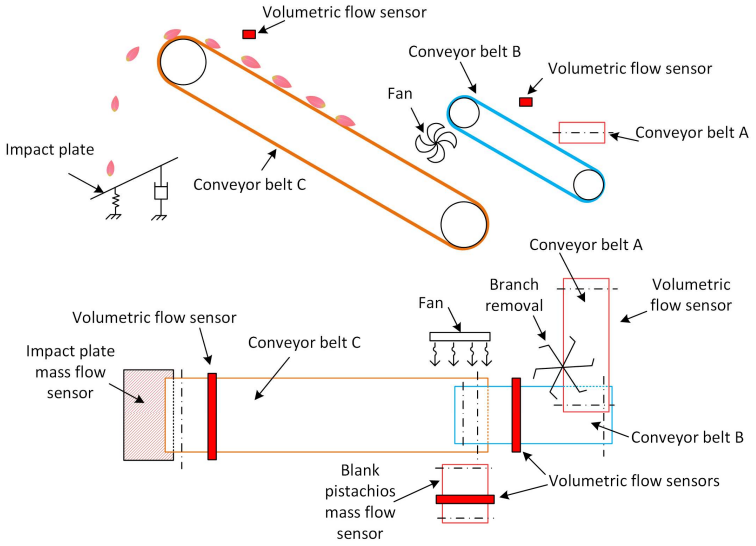
Cons:

- Wiring required
- Harvester's metallic body can distort and amplify/reduce signals
- High sensitivity to environmental variables like temperature and humidity, causing inaccurate data
- High technical expertise required to communicate with technical support
- Costly

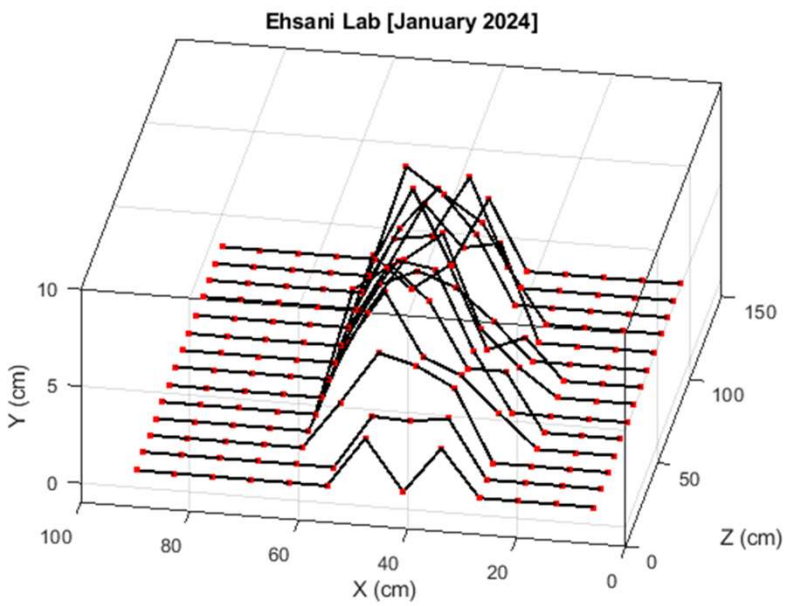
Yield Monitoring System for Pistachio Mechanical Harvesting Machines

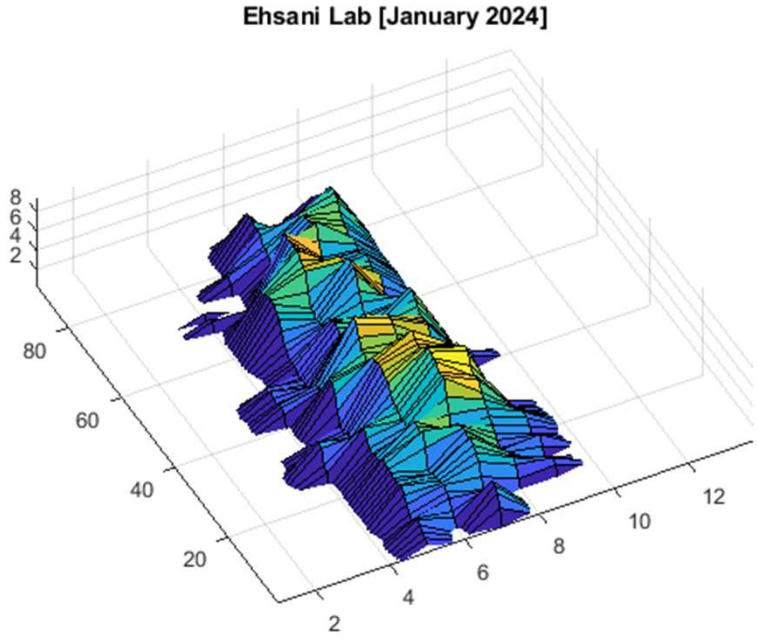
A single volume-based flow rate (VFR) sensor





Example of Results





Optical System

Pros:

- More reliable than electromagnetic-based system
- Excellent output from a single sensor
- Small-size signal conditioning and data processing system suitable for multi-sensor system
- High-speed data processor, increased sampling rate significantly
- Advanced communication system for higher real-time speed and more accuracy

Cons:

- Difficulties in combining multiple sensors at high sampling rates
- Optical interference issues

Acknowledgments

- We are thankful to the Wonderful Company for accommodating us for some of the field tests.

Also, special thanks to the following funding agencies for supporting these projects

- California Pistachio Research Board
- USDA SCRI program
- USDA- The AI Institute (AgAID)

THANKS & QUESTIONS