Engineering Needs for Tree Fruit Industry

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Engineering in Agriculture

High efficiency; Automated; Very few worker

Engineering Needs in Tree Fruit Production

Engineering Needs in Harvesting

❑ Background

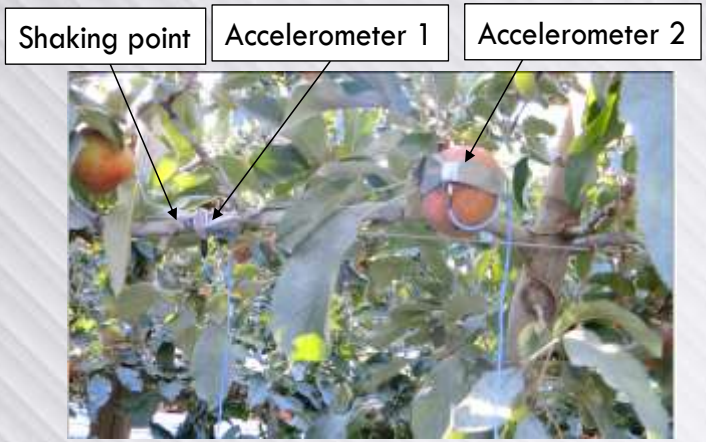
- U.S. is the second largest apple producer
- Manual picking is the only way today
- Issues on labor shortage and high cost
- Ladder related injuries

Shake and Catch Harvesting

- System Development

Shake and Catch Harvesting

❑ Fruit Dynamic Response



❑ Tree Canopy Architectures

❑ Pruning Strategies

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Shake and Catch Harvesting

Robotic Harvesting

- WSU Robotic Picker

- Abundant Robotics

- FF Robotics

Pruning for Tree Crops

❑ Pruning Strategies

- Dormant pruning
- Summer pruning
- Horticultural pruning rules

❑ Pruning Tools

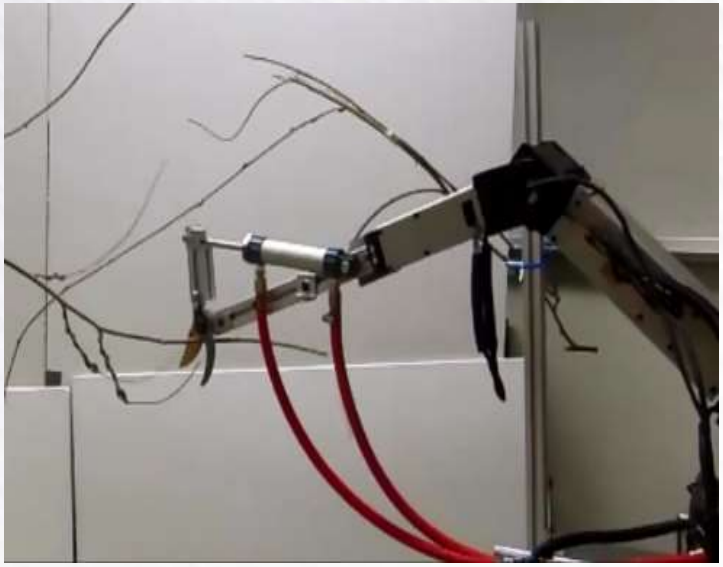
- Hand-held pruner
- Hedge pruning machine
- Robotic pruner

Pruning for Tree Crops

❑ Hedging Pruning

- High efficiency
- Low cost
- Non-selective

❑ Robotic Pruning



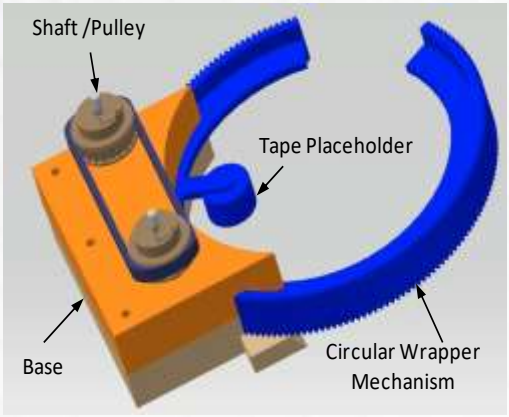
- Low efficiency
- High cost
- Selective

Tree Canopy Training

- **Tree Architecture Forming**

Tree Canopy Training

❑ Training Methods and Mechanisms



Autonomous Orchard Platform

- **Tractor-Pull or Self-Propelled**

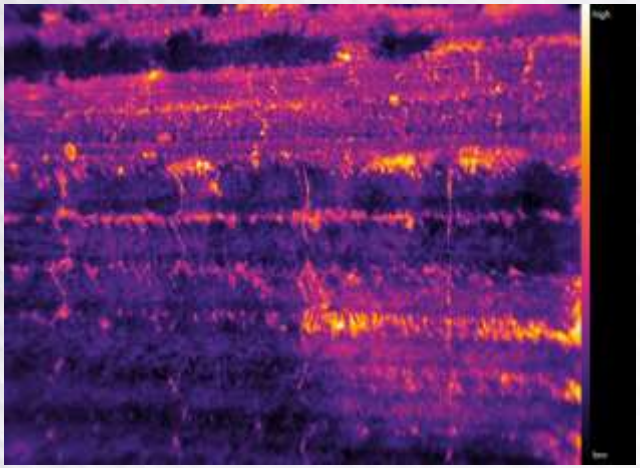
Autonomous Orchard Platform

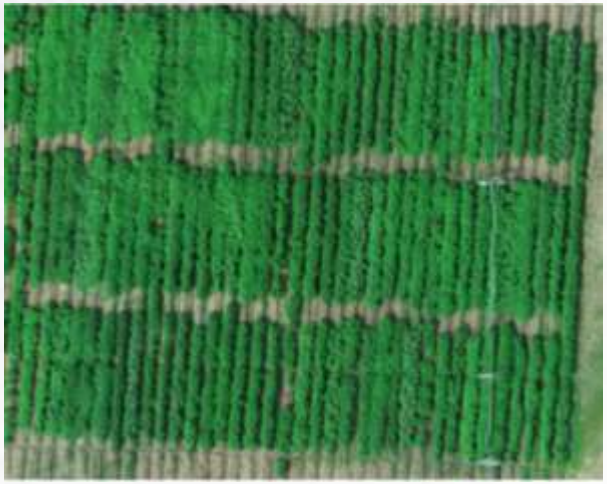
❑ Automated Bin-Handling Platform

- Electro-hydraulic power
- Four-wheel-independent steering system
- GPS navigation
- Laser scanner for bin detection

Crop Condition Monitoring

- **Stress Monitoring (crop health)**
  - Automated irrigation system (crop water stress)
  - Crop growth monitor -- NDVI
  - Pest and disease

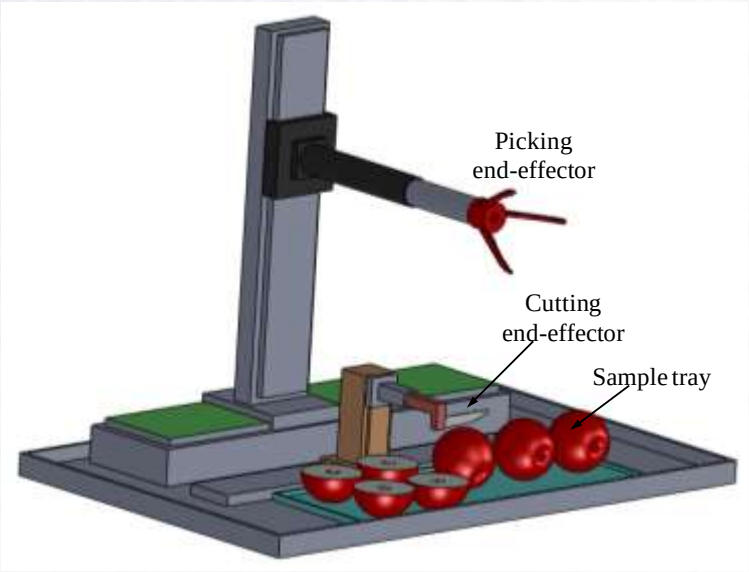




Crop Condition Monitoring

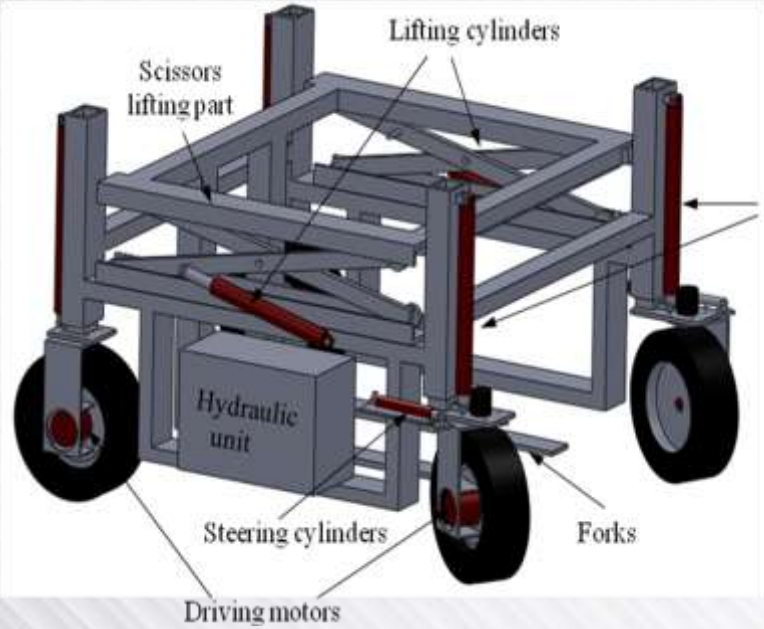
- **Fruit Maturity and Yield Estimation**

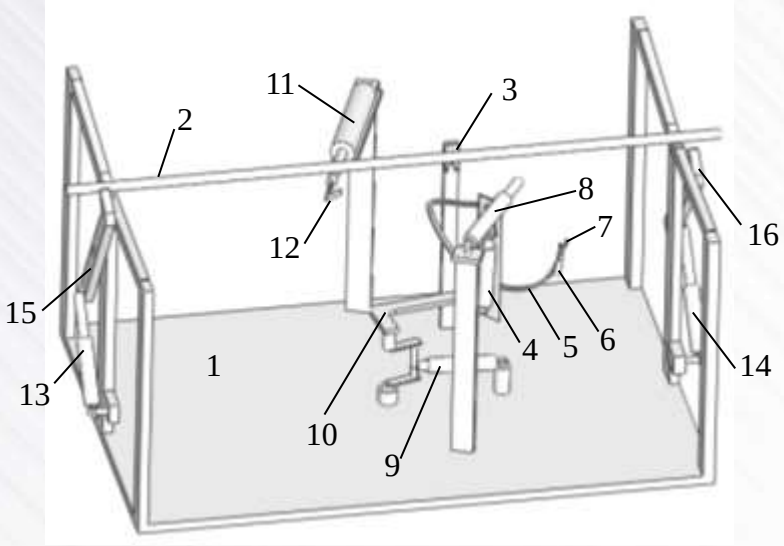
(Choi, 2017)



Core Technology: Mechanical Design

❑ Machine Design and Assembly



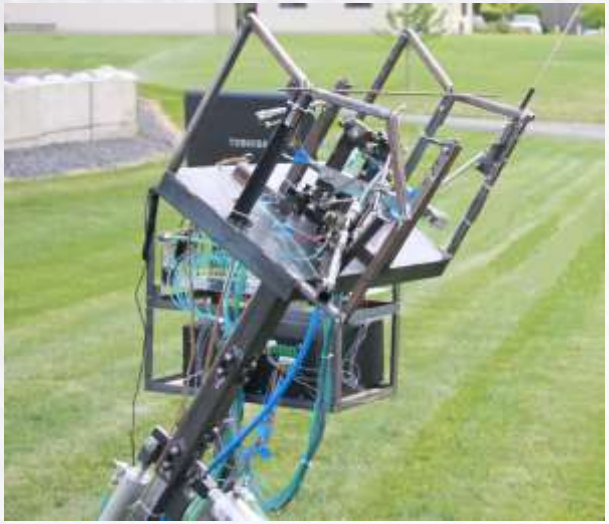


- Concept
- Mechanisms
- Assembly

Core Technology: Actuating System

- Hydraulic System

- Pneumatic System



- Electric System

Core Technology: Control System

- **Control and Communication**
  - Controller/Microcontroller
  - Control Strategies
  - Signal communication

PLC controller

Microcontroller

Core Technology: Auto Guidance

- **Core Components**

- **Applications**

Core Technology: Machine Vision

❑ Major components

RGB camera

Stereo camera

Kinect sensor

Spectrum Camera

❑ Application

Apple detection

Tree branch detection

Core Technology: Sensing Technologies

❑ In-Field Sensing

❑ Remote Sensing

Ground base sensing

UAV base sensing

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Thank You!

Questions and Comments