Development of a Ground-Based Platform for Plant Phenotyping and Crop Management Decisions

Murilo Maeda, Juan Landivar, Josh McGinty, Jinha Jung, Anjin Chang, Ruizhi Chen, Tianxing Chu, and Juan Enciso
Introduction

Objectives:

• Affordable advanced sensor technology

• Flexible platform

• High-throughput data collection

• Field mapping, phenotyping, and precision management decisions
What are we looking for & why?

- Canopy temperature
- Plant water status
- Plant growth rates
- Plant morphology
- Photosynthetic efficiency
- Indicators of plant stress

WHY?

Plant performance = YIELD

Images: Fahlgren et al. 2015
Applications

- Genotype evaluation
- Insect resistance
- Disease resistance
- Earliness
- Stress tolerance (e.g. drought)
- Irrigation water
- Fertilizer
- Growth regulator
- Disease / Insects
- Weeds
Platform & Sensors

- Spider (Lee Co., Idalou, TX)

- Infrared Radiometer SI-111 (Apogee Instruments, Inc., Logan, UT)

- NDVI
  - Decagon SRS (Decagon Devices Inc., Pullman, WA)
  - GreenSeeker (Trimble Navigation Limited, Sunnyvale, CA)

- Sonar ranging (Plant height)
  - SR50A (Campbell Scientific Inc., Logan, UT)
  - TS14 (Senix Co., Hinesburg, VT)
  - MB7092 (MaxBotix Inc., Brainerd, MN)

- Global Positioning System
  - Trimble
  - Garmin
The System

- Ultrasonic Sensor
- Multi Spectrum
- Infrared Canopy Temperature
- GPS Antenna
- Air T & RH Sensors
Data Collection / Sync

Data Match by GPS time

Trimble (Nomad 900)

CR100 (Datalogger)

GPS Receiver (GPS16X-HVS)

Sonic ranging (TS14, SR50A, MB7092)

Infrared Temp. (SI-111)

Multi-spectral (SRS)

GPS Receiver (AgGPS 162)

Air Temp. + RH (HC2S3)

Multi-spectral (GreenSeeker)
Monster Trial (NDVI) – 6/26/2015
Differences in GPS Accuracy

Trimble - GreenSeeker

Garmin - Decagon
Monster Trial (NDVI) – 7/17/2015

* Bars represent ± SE
SR50A: Tape vs. Sensor (Stationary)

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<th>Sensor (cm)</th>
<th>Tape</th>
<th>Sensor</th>
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- **Left Sensor**
  - Average: 91.8
  - Standard Deviation: 6.8

- **Right Sensor**
  - Average: 92.8
  - Standard Deviation: 7.0

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**Graph:**

- Blue diamonds: Left sensor
- Red squares: Right sensor

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**Graph Legend:**

- Left sensor
- Right sensor
Plant Height (Peppers in 20cm beds)

Data points

Soil surface

Plant height (m)

Data points

AgriLIFE RESEARCH
Texas A&M System
Sonic Ranging - Simulated

Ground Platform Moving Direction

Sonar sensor: Measurement frequency up to approx. 50 Hz
LiDAR - Simulated

Ground Platform Moving Direction

LiDAR sensor: Measurement frequency = 200 Hz
Conclusions

• Sensors are reasonably priced
• There is still a lot of manual data sorting
• Garmin GPS receiver does not provide high enough accuracy
• NDVI measurements from GreenSeeker are consistent
• Sonic ranging may be replaced by LiDAR
What is next?

• Increase data collection (to match UAS)

• Integrate Trimble system into the CR1000

• Replace sonic ranging sensors

• LiDAR likely to increase:
  – Plant height measurement accuracy
  – Data throughput
Thank You!

- Dr. Juan Landivar
  Texas A&M AgriLife
  Corpus Christi

- Dr. Jinha Jung
  Texas A&M
  Corpus Christi

- Dr. Ruizhi Chen
  Texas A&M
  Corpus Christi

- Dr. Anjin Chang
  Texas A&M
  Corpus Christi

- Andrea Maeda, M.Sc.
  Texas A&M AgriLife
  Corpus Christi

- Dr. Josh McGinty
  Texas A&M AgriLife
  Corpus Christi

- Dr. Chenghai Yang
  USDA-ARS
  College Station

- Dr. Juan Enciso
  Texas A&M AgriLife
  Weslaco

- Dr. Tianxing Chu
  Texas A&M
  Corpus Christi

Recommended Presentations:
- Dr. Juan Landivar
- Dr. Jinha Jung
- Dr. Anjin Chang
- Dr. Ruizhi Chen