Emerging Technologies for Precision Management in Vegetables

Precision Engineering Program

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Agricultural and Biological Engineering Department,
University of Florida
4th Agricultural Revolution

Digital Farming / Big Data / Internet of Things (IoT)

Smart Farming / Smart-Intelligence Machinery

Robotics / Artificial Intelligence (AI) / Automation
UAV Imaging

- Thermal
- Multi-Spectral
- Hyperspectral
- Visual – RGB
- LiDAR
UAV-based EDIS Documentation

Remote Pilot License Training

Tuesday, April 30th, 2019
9:00 a.m. - 3:45 p.m.
UF / IFAS Southwest Florida Research and Education Center
2685 SR - 29 / Immokalee, Florida 34142

In order to obtain a Remote Pilot Certificate from FAA under the Small UAS (Part 107) rule, you must pass the initial aeronautical knowledge exam. This training will prepare you to pass this exam and obtain your certificate.

What you learn:
- Airspace and Aeronautical Symbols
- Aeronautical Charts
- FAA Part 107 Regulations
- Airspace Classification
- Aviation Weather
- Risk Management
- and much more ...........

Register for your spot on the Eventbrite link ($75 per person) below.
There is no registration fee for extension agents, and UF faculty, students and staff ($10 is requested for lunch). Still need to register here:
https://www.eventbrite.com/e/remote-pilot-license-training-tickets-59955736221
Lunch is provided.

For questions, call 239-658-3415 or email Jennifer Derleth at jderleth@ufl.edu.

Agenda
- 9:00-9:15 am
  - Opening remarks and introductions - Dr. Yiannis Ampatzidis and Jennifer Bearden - 15 min
- 9:15-9:55 am
  - Section 1 – Aircraft identification and registration – 30 min
    - Break/questions – 10 minutes
- 9:55-11:15 am
  - Section 2 – Airspace and Aeronautical Symbols – 50 min
  - Sectional Chart Reading Activity – 20 min
  - Break/questions – 10 minutes
- 11:15-12:15 pm
  - Section 3 – Aviation weather and effects – 50 min
  - Lunch Break
- 1-1:20 pm
  - UF procedures – John Rouse – 20 min
  - Section 4 – Risk management – 30 min
  - Break/questions – 10 min
- 1:20-2 pm
  - Section 5 – Aeronautical knowledge – 30 min
  - Applications in Agriculture – Yiannis Ampatzidis and Jennifer Bearden – 30 mins
- 2:45-3:15 pm
  - Final questions – 20 min

Planning Committee: Yiannis Ampatzidis, Jennifer Bearden, Jim Fletcher, Gene McAvoy
KIWI UAV Spraying System
Agroview – settings
Agroview – add block

Select an upload option

- I have multiple UAV collected images to upload
- I have a processed UAV orthomosaic map to upload
Agroview – create field boundaries
Agroview – farm analytics
Agroview – field analytics
Cloud-based application to process, analyze, and to visualize UAV collected data

https://twitter.com/i/status/1202671242647490560
Best Management Practices
Machine Learning Prediction Model: Gradient Boosting Regression

Workflow of the dataset collection, analysis and regression model

- UAV Data collection
- Multispectral data
- Leaf Laboratory Analysis
- Tree Plot Nutrient Composition
- Statistical Analysis of dataset
- Gradient Boosting Regression Tree
- Model

Whisker plot of the distribution of errors for each nutrient

Bland and Altman diagram for nitrogen measurements

Nutrient Prediction Error

- N %
- P %
- K %
- Mg %
- Ca %
- S %
- B ppm
- Zn ppm
- Mn ppm
- Fe ppm
- Cu ppm

Mean diff: -0.0
+SD1.96: 0.25
-SD1.96: -0.25

Difference vs Means
## Best Management Practices

**UAV-based Nutrient Estimation and Precision Fertilizer Applications**

<table>
<thead>
<tr>
<th>Manual Data Collection</th>
<th>UAV-based with Agroview</th>
</tr>
</thead>
<tbody>
<tr>
<td>800 trees (Hamlin and Valencia)</td>
<td>5,000 trees</td>
</tr>
<tr>
<td>8 hours sample collection</td>
<td>30 min flight</td>
</tr>
<tr>
<td>4 people</td>
<td>1 person</td>
</tr>
<tr>
<td>2 weeks lab analysis</td>
<td>5 min analysis</td>
</tr>
<tr>
<td>Estimated cost: $10,500</td>
<td>Estimated cost: $100</td>
</tr>
</tbody>
</table>
Vineyard Map - NDVI
Detection of target spot and bacterial spot diseases in tomato using UAV-based hyperspectral imaging
Spectral reflectance signatures of *Tomato yellow leaf curl virus* (TYLCV, on susceptible and resistant tomato varieties), Bacterial Spot (BS), and Target Spot (TS) infected tomato plants

Spectral reflectance signatures of healthy squash plants and Powdery Mildew (PM) infected plants in different disease development stages (asymptomatic, early and late stages).
Detecting Skips in Sugarcane Fields
Yield prediction in winter wheat under stress environmental conditions

- Panel B: 260 genotypes (2017-2018) under irrigated and drought conditions.

- Plot size: 5.1 m² (3.3 x 1.52 m)

- UAV-based hyperspectral data (400–1000 nm) at 200 ft (last fight: 1 month before harvest).
Yield prediction in winter wheat under stress environmental conditions

Mean Absolute Percentage Error (MAPE) for each group in the cross-validation of Panel A.

<table>
<thead>
<tr>
<th></th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
<th>Group 5</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAPE</td>
<td>15.6%</td>
<td>10.2%</td>
<td>12.2%</td>
<td>12.0%</td>
<td>17.1%</td>
<td>13.4%</td>
</tr>
</tbody>
</table>

Whisker graph for the error in yield prediction for Panel A.

Bland and Altman diagram in percentage for the Panel A dataset.
Example: more than 90% of the cropland in the U.S. are being sprayed by more than 3 billion pounds of herbicides that costs around $26 billion each year.

Overuse of these chemicals creates *herbicide-tolerant weeds with around 250 known species of resistant weeds.*
“The Trimble® GreenSeeker® crop uses optical sensors to measure and quantify crop health—or vigor. It can precisely manage crop inputs on-the-go. With GreenSeeker, you can address field variability by applying the right amount of fertilizer, in the right place, at the right time.”

https://agriculture.trimble.com/product/greenseeker-system/
Artificial Intelligence for Precision Pest Management in Vegetables and Strawberry

Precision Weeding
Blue River Technology

See & Spray every weed

- 5,000 plants per minute
- 40 acres/day by one machine
- ¼ precision in inches at 4 mph
Smart Weed-Killing Robots

Precision Sprayer (PS) for Weed Management

Experimental Design

Portulaca (target weed)
Sedge (non-target weed)
Pepper plant (non-target)
Precision Sprayer (PS) for Weed Management

Smart Technology for Weed Management

Crop: Pepper
No-Target
Target weed: Sedge
Target weed: Portulaca

https://twitter.com/i/status/1045013127593644032
Precision Sprayer (PS) for Weed Management Demo/Video

Smart Technology for Weed Management

Crop: Pepper

Target

No-Target

weed: Sedge

Target weed: Portulaca

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https://twitter.com/i/status/1045013127593644032
Precision Sprayer (PS) for Weed Management

Precision Sprayer (PS) for Weed Management

High Throughput Multi-Robot Weed Management for Specialty Crop

High Throughput Multi-Robot Weed Management for Specialty Crop

Potential to Mechanically Harvest Specialty Crops

Types of Machinery
- Harvest-aid systems
- Trunk shakers
- Canopy shakers
- Entire crop harvesters
- Fruit harvesters (robotic arms, vacuum systems etc.)
- Robots
Agrobot Strawberry Harvester

https://www.youtube.com/watch?v=RKT351pQHfI

https://www.youtube.com/watch?v=RKT351pQHfI
Tomato Robotic Harvester
Four Growers

https://www.youtube.com/watch?v=-qQffIHmlXk&feature=youtu.be
Harvey the Robotic Capsicum (Red Pepper) Harvester

https://www.youtube.com/watch?v=8rq4iSTsg68
Strawberry Robot in Japan

https://www.youtube.com/watch?v=9Su2XQyuavM
Mechanization of Strawberry Harvesting for Long Term Sustainability

Questions/Comments?  
Thanks for your attention!

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