Aerial Mapping in Agriculture with sUAS

February 26, 2019
Remote Pilot Forecast

Source: 2018 FAA sUAS Report
sUAS Non-Model Registrations

400-650% increase in the number of drones over the next 5 years

Source: 2018 FAA sUAS Report
Commercial sUAS Distribution

Source: 2018 FAA sUAS Report
Present Uses for Non-model sUAS

Source: 2018 FAA sUAS Report
Disaster Assessment

Tomato
Disaster Assessment
Disaster Assessment
Disaster Assessment
Disaster Assessment
INTEGRATING UNMANNED AERIAL SYSTEMS WITH WIRELESS SENSOR NETWORKS FOR SUSTAINABLE WATER MANAGEMENT
GRID SAMPLING
MOISTURE MAPPING

3-9-2018

4-18-2018

5-4-2018

6-21-2018

7-17-2018

Symbol | Range
---|---
3.5 - 10
10.001 - 16
16.001 - 50
TISSUE MAPPING

N %

2-3-2018
3-9-2018
4-18-2018
5-4-2018
6-21-2018
7-7-2018

Symbol Range
0 - 1.9
1.900000001 - 3
3.000000001 - 3.52
Soil Mapping
P ppm

3/2/18

4/27/18

4/11/18

6/14/18

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Range</th>
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<tbody>
<tr>
<td></td>
<td>0 - 26</td>
</tr>
<tr>
<td></td>
<td>26.00000001 - 45</td>
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<td>45.00000001 - 400</td>
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SENSOR SPECTRUM

Visible
400 to 700 nm

Infrared
700 to 1,000,000 nm

Near IR
Short Wave IR
Mid Wave IR
Long Wave IR
Far Infrared

Thermal Infrared

Wavelength

100 nm = 1 um
1,000 nm = 10 um
10,000 nm = 100 um
100,000 nm = 1,000 um
1,000,000 nm = 1 mm

Picture courtesy: Globalsystemscience.org
Flow/Drainage Assessment
Flow/Drainage Assessment
MULTI-SPECTRAL NDVI
Hyperspectral results: Foliage

- **Tissue Nitrogen %**
  - $R^2 = 0.685$
  - $RMSE = 0.280$
  - Within $\pm$ RMSE = 81.48%
  - $RMSE/Range = 13.011$

- **Tissue Potassium %**
  - $R^2 = 0.750$
  - $RMSE = 0.144$
  - Within $\pm$ RMSE = 84.62%
  - $RMSE/Range = 11.300$
Hyperspectral results: Soils

**Soil Phosphorus mg/Kg**
- $R^2 = 0.376$
- $RMSE = 0.495$
- Within $\pm RMSE = 92.31\%$
- $RMSE/Range = 17.646\%$

**Soil pH**
- $R^2 = 0.754$
- $RMSE = 0.458$
- Within $\pm RMSE = 70.37\%$
- $RMSE/Range = 12.938\%$
Thermal results: Soils

Thermal sensor data (°C) vs. Soil moisture content (%)

Equation: $y = -0.0957x + 40.351$

$R^2 = 0.1552$
MIL Evaluation
Multispectral MIL Evaluation

MIL 3 Before

MIL 3 After
Thermal MIL Evaluation

MIL 1 Thermal Before

MIL 1 Thermal After
Take home points:

• ‘Generic’ visual/multispectral sensors may not be very useful for tracking nutrient status, plant performance indicators,
  ✓ Useful for assessing crop density, basic plant vigor, and phenology
  ✓ Disaster Assessment
• Hyperspectral data good for tracking plant nutrient status
  ✓ ...maybe even soils
• Thermal imagery may be useful for tracking stress and MIL evaluation
  ✓ ...but more research needed
“More Crop for the Drop”

Questions