Development of an Inventory Management Tool for Nurseries Using an Unmanned Aerial Platform

INVENTORY MANAGEMENT

- Commonality between growers
- Estimates based on small percent of population
- Inaccurate
- Increasing technological advancements
- Decreasing technology costs
- Increasing labor cost and decreasing availability
- Enhanced inventory projections
- Quantitative analysis at time of harvest

The Future of Nursery Automation

By Ray E. Young

Computerized inventory-handling systems will revolutionize the greenhouses of the future.

Images of American Nurserymen provided by Jim
WHY AERIAL?

- Eliminate issues with terrain
- Cover large area at one time
- Decreased technology costs
- Decreased nursery time and cost
- Increased accuracy
- Data readily available
- Future applications
  - Crop scouting
  - Bare soil imagery
  - Irrigation and drainage planning
  - Academic and Extension Education
Evaluating a More Sustainable Control Release Fertilizer for Ornamental Crops using a Struvite Byproduct from Waste Water Treatment

REMOTE AERIAL PLATFORM

ADVANTAGES:
- Lower cost (< $10,000)
- Ease-of-use; on-demand capability (can be flown by any trained grower/farmer)
- Higher resolution (1 inch)
- Lower altitude (< 400 feet)
- Vertical take-off and landing
- Greater payload capacity than most unmanned aerial vehicles (2.5lbs)
- Multi-rotor platform is more stable and compared to single rotor helicopter
REMOTE AERIAL PLATFORM

- MiKroKopter US, Watsonville CA
- Altitude control
- GPS position
- Waypoints navigation
- Payload: 250 – 1 kg
- Radio control transmitter
  - 2.400 ~ 2.483 GHz
  - 1 – 2 km range
- Total Weight (without battery) 1260 g
- Maximum altitude 350 m
- Maximum speed 8 m/s
Roll and pitch compensated
Shutter and controls can be operated using the R/C transmitter.
Sony NEX-5 camera
  - APS HD CMOS sensor
  - 14.2 megapixels
  - Weight: 10.1 oz (287g)
Sony SEL 16mm f/2.8 wide-angle lens
EXPERIMENTAL DESIGN

• Three Altitudes
  • 35m, 60m, 85m

• Three Production Systems
  • Container
    • Barberry
    • Pear
    • Rhododendron
      • #1, #2, #5
  • Shade Tree
    • Maple
  • Christmas Tree
    • Douglas Fir
Evaluating a More Sustainable Controlled Release Fertilizer for Ornamental Crops using a Struvite Byproduct from Waste Water Treatment

SPECIES AND FORM
CONTAINER OR PLANT SIZE

Images taken at 35 meters
DATA COLLECTION

- Ground truth
- Computer generated count
  - Object based image analysis (OBIA)
- Manual image accuracy count
  - Single
  - Double
  - Triple or greeter
  - Erroneous count (weeds, etc.)
- Accuracy
  - Net
    Measure of all plants correctly identified through OBIA approach compared to manual count
  - Overall
    Measure of overall accuracy of OBIA approach by including missing as well as unidentified points on the analyzed image.
OBJECT IMAGE BASED ANALYSIS

Images of #1 Rhododendron PJM at 35 m
OBJECT IMAGE BASED ANALYSIS

Images of #1 Rhododendron PJM at 35 m
Evaluating a More Sustainable Control Release Fertilizer for Ornamental Crops using a Struvite Byproduct from Waste Water Treatment

Barberry (containerized shrub)

<table>
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<tr>
<th>Altitude (m)</th>
<th>Net</th>
<th>Overall</th>
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<tbody>
<tr>
<td>35</td>
<td>97</td>
<td>95</td>
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<td>60</td>
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<td>85</td>
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ACCURACY(%)
Pear (containerized shade tree)
Pear (containerized shade tree)

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<td>60</td>
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Douglas fir (Christmas Tree)
### Douglas fir (Christmas Tree)

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<table>
<thead>
<tr>
<th></th>
<th>Ground truth</th>
<th>Algorithm</th>
<th>Missed</th>
<th>Double</th>
<th>Triple</th>
<th>Erroneous</th>
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<tbody>
<tr>
<td>Plant Count</td>
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</table>
Rhododendron (varying container size)
Rhododendron (containerized shrub of varying size)

Images of #1 Rhododendron PJM at 35 m
CONCLUSIONS

- Today:
  - Obtain images
  - Geographic position
  - Success OBIA count
    - Containers
    - Christmas Trees
  - Unsuccessful OBIA count
    - Impact of altitude
    - Canopy overlap
- Next Steps:
  - Improved algorithm
  - Multispectral imagery
  - Composite imagery
  - Using light and shadows
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Commercial Horticulture
Nursery Automation

Team Members

- Dr. Reza Ehsani - UFI
- Dr. Joe Maja - UFI
- Dr. Jim Owen - VPI
- Dr. Chal Landgren - OSU
- Heather Stoven - OSU
- Dr. Dharmendra Saraswat - UofA
- Dr. James Robbins - UofA
- Sam Doane - J. Frank Schmidt & Son Nursery
- Ross Dumf - Bailey Nurseries

PowerPoint Presentations (PDF)

- Quantification of Tree-Geometric Characteristics: Sensor Platform and UAV (PDF) - Dr. Ehsani, September 9, 2010
- On-the-Fly Tree Caliper Measurement (PDF) - Dr. Owen, September 9, 2010
- How Did We Get Here? (PDF) - Dr. Robbins, September 9, 2010
- Remote Sensing for Tree Counting (PDF) - Dr. Saraswat, September 9, 2010
- Aerial Approach to Inventory Management for Container and Field Nursery Production (PDF) - Dr. Ehsani, August 25, 2011
- ANLA ‘Kick-the-Dirt’ Seminar (PDF) - Dr. Robbins, August 25, 2011
- Unmanned Aerial System for Precision Agriculture (PDF) - Drs. Robbins/Saraswat, October 4, 2011
- SNA Research. Conference (PDF) - January 18, 2012

Papers

- Proc. SNA Research. Conference, 2012 (PDF)

Articles

- NM Pro Magazine, November 2010: ‘Picture This’ (PDF)

http://www.aragriculture.org/horticulture/nurseryAutomation/default.htm