UAV Imagery and Data Management for Precision Agriculture

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UAS in Precision Agriculture

• NDSU UAS & Sensing Activities

• Digital Data Management Issues

• Future of Digital Data in Agriculture
Precision Agriculture & Data Management

Telematics
Data in Precision Agriculture

- Fertilizer Application Map
- Seeding Application Map
- Scouting Map
- Chemical Application Map

- Aerial Imagery
- Aerial, Satellite & UAS Imagery
- Soil Map
- Yield
- Soil
- Elevation
- Imagery
GPS 96%
RTK GPS 46%
Section Control on Sprayers 81%
Row Control on Planters 55%
Section Control on Air Seeders 20%
Yield Monitors on Combines 83%
Variable Hybrid Seeding 20%
Variable Rate Seeding 49%
In-season Fertilization 29%
In-field Sensors 4%
Zone Management in Fields 35%
Drones in Ag 15%
Imagery for Crop Management 40%

Precision Ag Technologies in North Dakota
NDSU UAS Activities
Small and Large UAV

Phantom 3

Trimble UX5
UAS Sensors

Cameras

- GoPro Camera
- ICI 9640 S Thermal camera
- Large area scanning EO/IR/NIR camera
- Sony NEX-5R camera with NIR
- Tetracam ADC
- Sentera dual sensor (4 band)
- Sentera Quad sensor (6 band)
- MicaSense Rededge
- Ximera Hyperspectral sensor
- Rikola Hyperspectral sensor
Phantom Quad Sensor
- 4 Cameras in One
Image Processing Software

- Pix4Dmapper
- Agisoft Photoscan Pro
- UnscramblerX
- SlantView
- Rikola Hyperspectral Imager
- ArcMap
- ERDAS Imagine
- ENVI
- Matlab
- QGIS
- SMS Spatial Management Systems
Large-scale UAS Project

Imagery in May, June, July and August
- Color, Infrared Sensor
- 4,000, 6,000 and 8,000 ft

Small UAS, Satellite, Ground and Yield Data

All Imagery Securely Stored on NDSU Computers

Objectives

Uses for Crop Management
Economic Value to Producers
Project Location – Eastern ND
Project Location – Eastern ND

Large-scale UAS Data Collection for Field Crop Management

Legend:
- Towns
- Roads
- Large-scale Data Collection Corridor
- County Boundaries

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Hermes 450 UAS
Hermes 450 UAS – Control Center
First Large UAS Civilian Flight in United States
Landing the Hermes 450
View from CAP Chase Plane
Data Management

Large UAS – Entire Corridor Each Date

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<th>May 23-27</th>
<th>June 20-24</th>
<th>July 18-22</th>
<th>August 15-19</th>
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Total Quantity of Imagery Collected during the Project: **10.5 TB**
Plus Small UAS Imagery
Plus Image Analyses
Data Transfer Issues

• One North Dakota Field – 320 Acres, 2.45 GB
  – Transfer Time from NDSU Secure File Site
    2 minutes – Grand Forks Courthouse – Wired Connection
    4 minutes – Fargo Home – CableOne & Wireless
    7 minutes - Fargo Home – CableOne & Wireless
    9 minutes – Carrington Home – Cable & Wireless
    10 minutes – Cass County Courthouse – Wireless
    27 minutes – Richland County Courthouse
    53 minutes – Griggs County Courthouse
    1 hour and 10 minutes – NDSU CREC
NDSU Extension Role

- Facilitate
- Collaborate
- Educate
May Imagery: 4,000’ – 6,000’ – 8,000’

Detailed Imagery - 50,000 Acres/Hour
Digital Elevation Model Using Large UAV
Sunflower Stand 2017 – Skips and Doubles
Corn Imagery: May – June – July - August
NDVI
Trimble with MicaSense Camera

Mapping IDC in Soybeans
Planter Skips in Dry Edible Beans

NDVI
Trimble with MicaSense Camera
Hail Damage: Corn from 4,000’

17 Acres out of 67 acres
Cattle in August Imagery: 4,000'
~ 40 Acres
Imagery 4,000'
RGB Image
4 cm Pixel Size
Imagery Issues: Time Between Images
Imagery Issues: Time Between Images

Color Image
Imagery Issues: Time Between Images

NDVI Image

NDVI Mean = 0.6514
NDVI Mean = 0.4975
Identifying Volunteer Soybeans in Dry Beans Fields

Soybean - Edible Bean Comparison

Reflectance

Wavelength

Soybean 1
Kidney Bean
Identifying Noxious Weeds

Spectral signatures of leafy spurge and surroundings

- Leafy spurge bracts
- Leafy spurge leaves
- Grass
- Background
- Litter
- Soil

Outside visible range

Wavelengths (nm)

Reflectance (%)

UAVs:
- DJI Phantom 3 & 4
- DJI Matrice 100

Cameras:
- Sentera Multispectral Cameras
- Slantrange Multispectral camera

Spectral signatures of purple loosestrife and surroundings

- Purple Loosestrife
- Grass
- Background
- Litter
- Soil

Wavelengths (nm)

Reflectance (%)

DJI Matrice 100

Slantrange Camera
Identifying Herbicide-resistant Weeds

Ragweed

Potentially significant wavelengths

Reflectance

0.6

0.5

0.4

0.3

0.2

0.1

0

506 558 610 662 714 766 818 870

Wavelength (nm)

Resistant

Susceptible

Resistant sprayed

Susceptible sprayed

DJ Spreading Wings

1000+

Rikola Hyperspectral camera

NDSU NORTH DAKOTA STATE UNIVERSITY

NDSU EXTENSION SERVICE
Identifying Herbicide-resistant Weeds

#1 Herbicide-resistant
Cooler

#2 Herbicide-susceptible
2-5 degrees warmer
Robotic Probe
Future of Data in Agriculture

- More In-field Sensors
- More Machine Sensors
- More Remote Sensing
- More UAVs
- More Robots

One More Layer for Big Data Precision Agriculture
Questions - Comments

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http://www.ag.ndsu.edu/agmachinery
Managing Large Amounts of Digital Data for Precision Agriculture

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Discovery and Innovation

critical implications for
R&E network infrastructure
Data transfer and storage ~

• By nature, production ag occurs in rural / remote areas, likewise the data for initiatives like this will originate in those same locations.
• To use the data for analysis, discovery and innovation, the data must travel or at least be accessible to experts from a distance.
Data privacy and security ~

• **Grower privacy** protect the grower’s crop production and business related data while ensuring timely access to key research data sets by partners.

• **Intellectual Property** allow universities to patent research discoveries and transfer the patent to the private sector.

• **Research transparency and replicability** ensures attention to data privacy concerns is rigorous, but does not stifle progress of public/private research initiatives intended to benefit global society and economy.
Emphasizing the R&E role ~

[State & Regional networks]

• **provide access** to scalable operating cyberinfrastructure models for effective and dynamic delivery of computational resources and services to geographically distributed researchers.

• **proximity to their campus members** and familiarity with regional priorities and interests... provide focus on challenges and opportunities characteristic of the region ...promote new capabilities and resources external to individual campuses.

(Monaco et al., 2016)
Implications for the Midwest Big Data Hub

Project Vision

Develop coordinated efforts by the academic, industrial and governmental sectors to automate Big Data lifecycles, improve access to data assets, and train a workforce with relevant skills and expertise, all contributors to solving sustaining global food security concerns.

Retrieved online: https://www.researchgate.net/publication/304628611_The_Role_of_Regional_Organizations_in_Improving_Access_to_the_National_Computational_Infrastructure_A_Report_to_the_National_Science_Foundation