

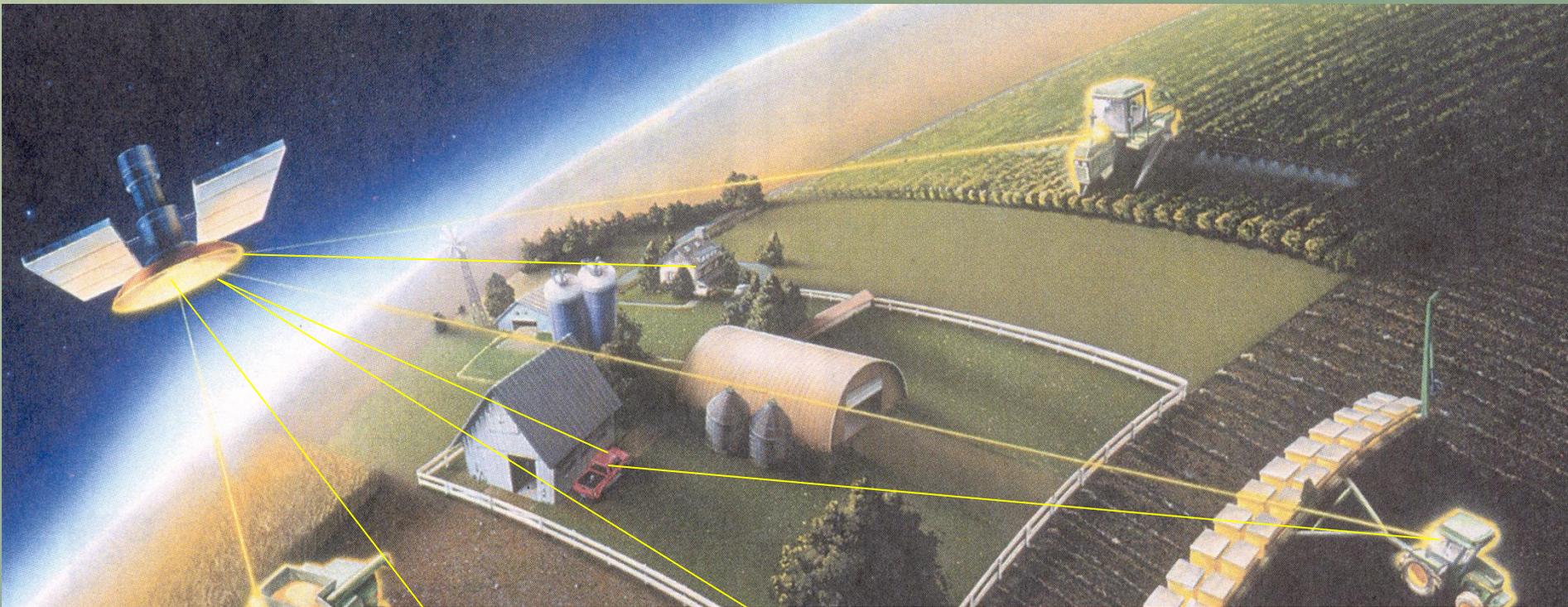
Precision Aerial Application- Past, Current and Future

Yubin Lan, W. Clint Hoffmann, Dan Martin

USDA-ARS

College Station, Texas

Precision Aerial Application



Outline

- Precision Aerial Applications
- Remote Sensing
- Variable Rate Technology
- Future Direction

Introduction

- Precision agriculture includes different technologies that allow agricultural professional to use information management tools to optimize agricultural production
- The new technologies allow aerial applicators to improve application accuracy and efficiency, which saves time and money for the farmer and the pilot

Introduction

(continued)

- Precision aerial application in the USA is less than a decade old since the development of the first variable-rate aerial application system
- Precision aerial application includes satellite, airborne and ground-based remote sensing, GIS/GPS and variable rate applications

Introduction

(continued)

- Research is underway to convert aerial images into application maps without a lot of effort or special knowledge from the pilot/operator, which could then be a new service to a customer
- These application maps could then be easily uploaded into the spray system computer to make variable-rate aerial application of plant growth regulators, defoliant, fungicides, and insecticides

Introduction

(continued)

- This presentation will discuss the various research components and how they will ultimately fit into a complete precision application package
- Since aerial applicators are flying over numerous fields between spray missions, these aircraft can be fitted with multispectral cameras that can detect crop diseases, water stress, and other adverse crop conditions

Precision Aerial Applications

USDA ARS APMRU AAT Projects

- Evaluate the PhotoNav system for automatically taking images, develop more sensors for the integrated sensor and instrumentation system
- Development of a robotic system (UAV Crop Meter System) for measuring crop conditions

Precision Aerial Applications

USDA ARS APMRU AAT Projects

- Use the newly obtained thermal imaging camera for crop pest management and crop nutrient deficiency studies
- Work on integrating crop model with remote sensing for developing a decision support system for aerial applicators

Precision Aerial Applications

USDA ARS APMRU AAT Projects

- Develop prescription maps for precise application of products at the locations and rates they are needed, thereby increasing application efficacy and effectiveness
- These prescription maps will cover both crop pest managements and crop nutrient deficiency needs

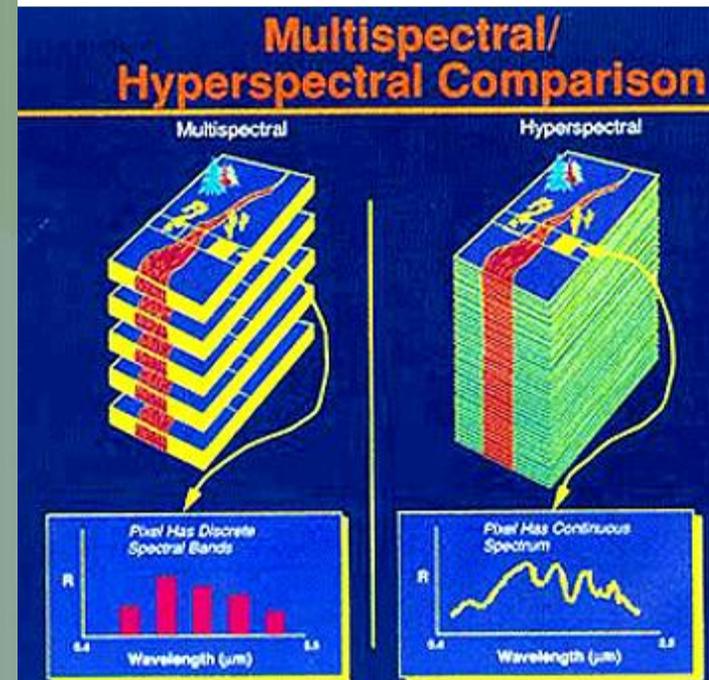
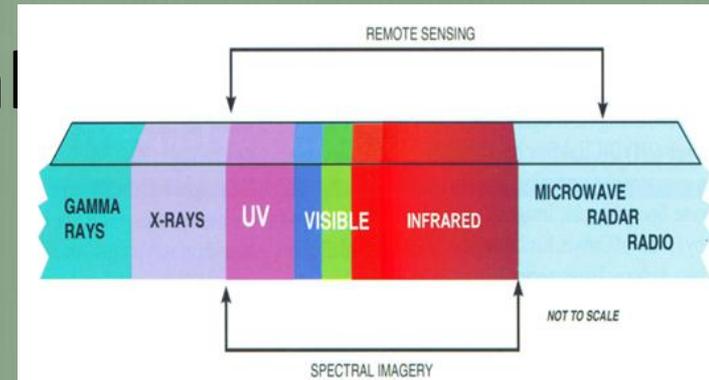
Objectives

- Focus on remote sensing and variable rate technology for precision aerial applications
- Discuss the current status of above two areas, will examine several current trends, and will conclude with suggestions for future development

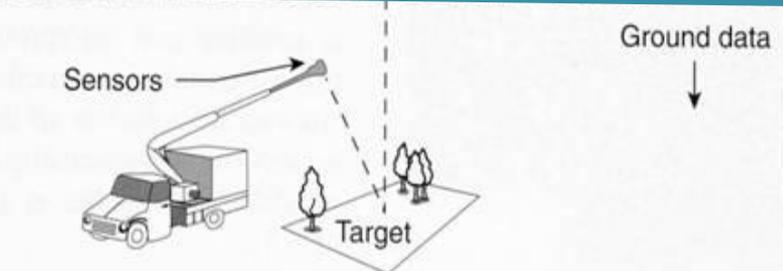
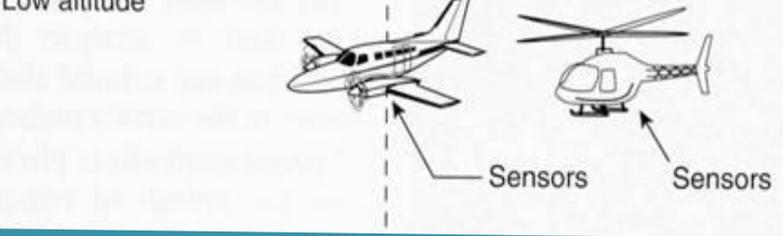
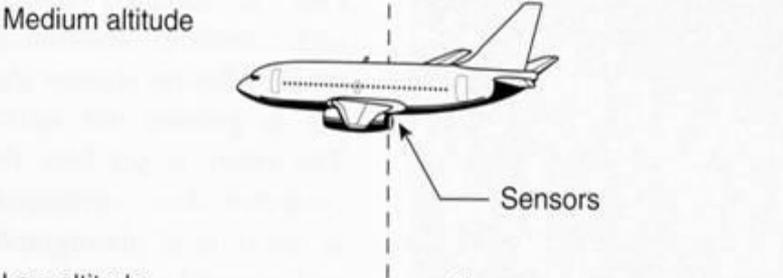
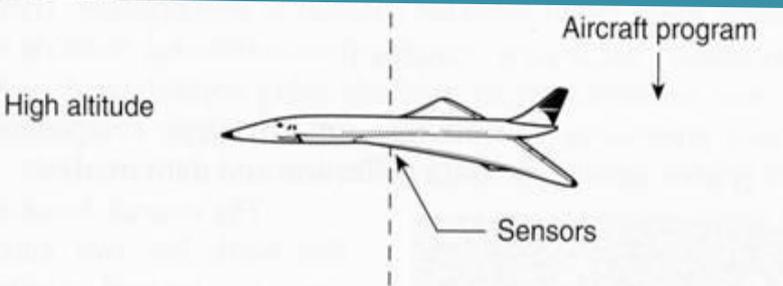
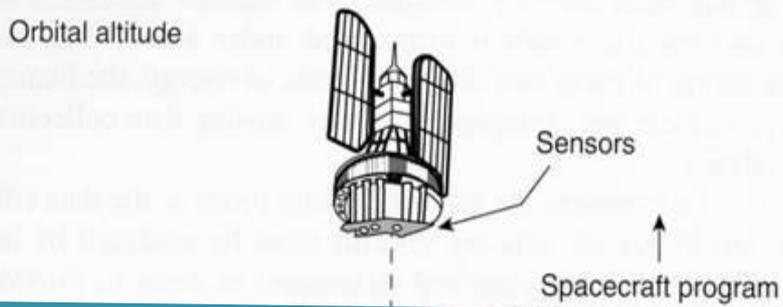
Remote Sensing

Multispectral and hyperspectral

- Space-borne: Satellites
- Airborne:
 - Piloted
 - Unmanned helicopter
- Ground truthing



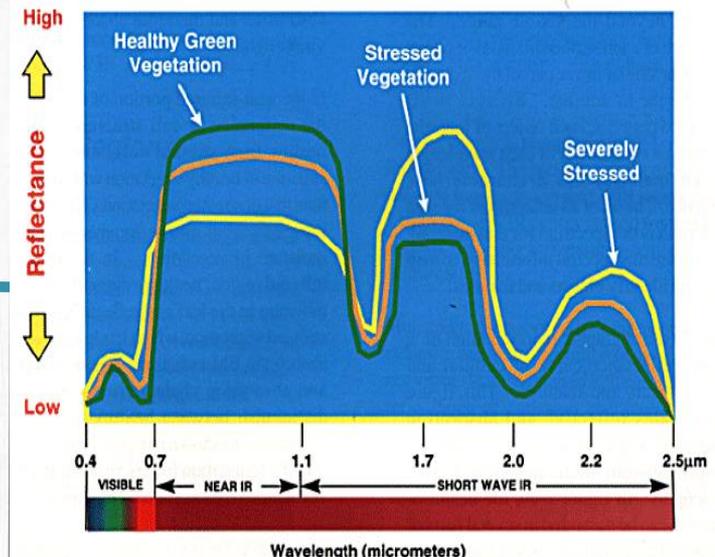
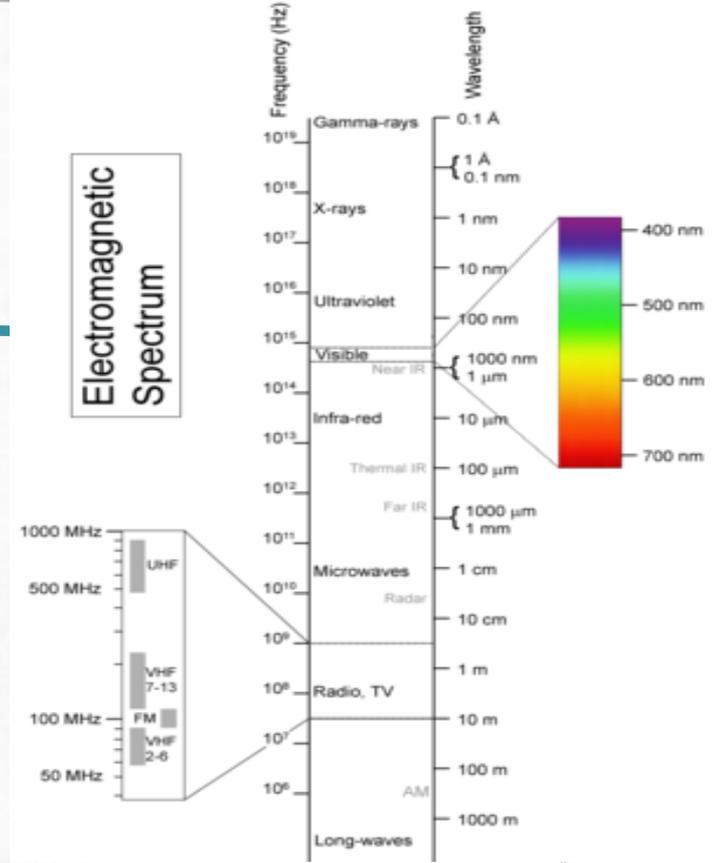
Satellite



Aircraft Helicopter UAV

Ground Vehicle or Hand-held

Electromagnetic Spectrum



Agricultural Digital Camera



Tetracam ADC Camera



UAV SR20

- A single 3.2 megapixel CMOS sensor
- Auto/manual exposure
- Green: 520 - 600 nm
- Red: 630 - 690 nm
- NIR: 760 – 900 nm
- GPS trigger: Sequential waypoint trigger through SensorLink



MS4100 and TerraHawk System



Cessna 206

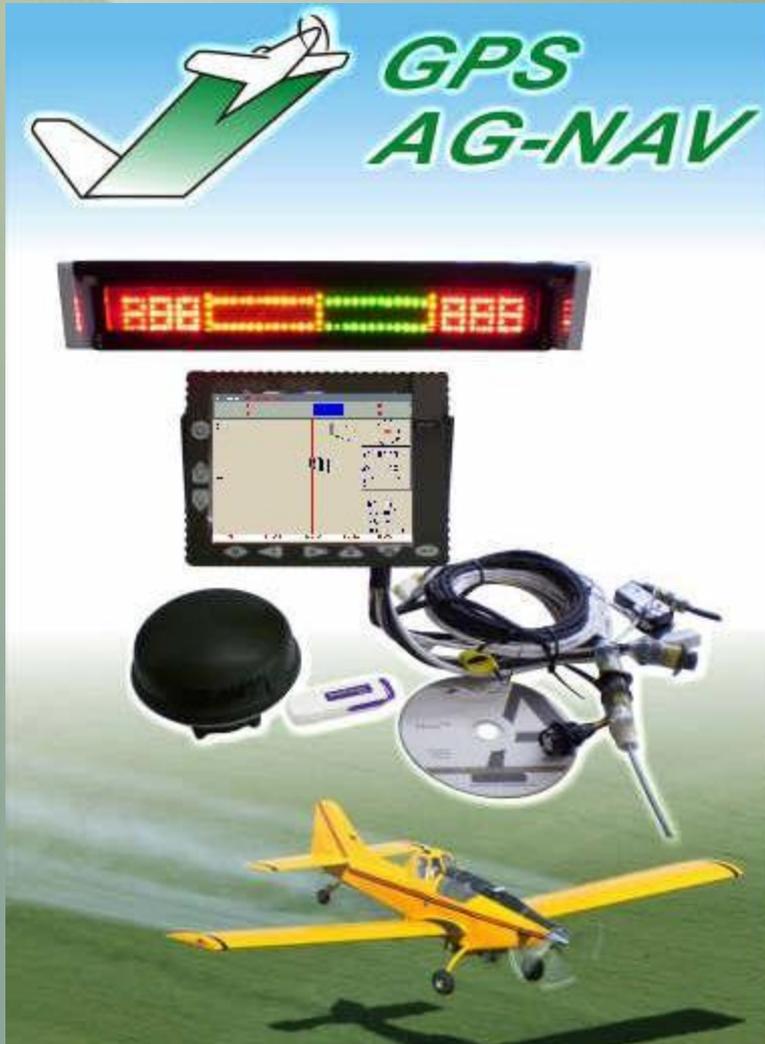


Airborne Multispectral Remote Sensing System



AG-NAV PhotoNav

For Aerial Photogrammetry and Remote Sensing applications



The PhotoNav system consists of

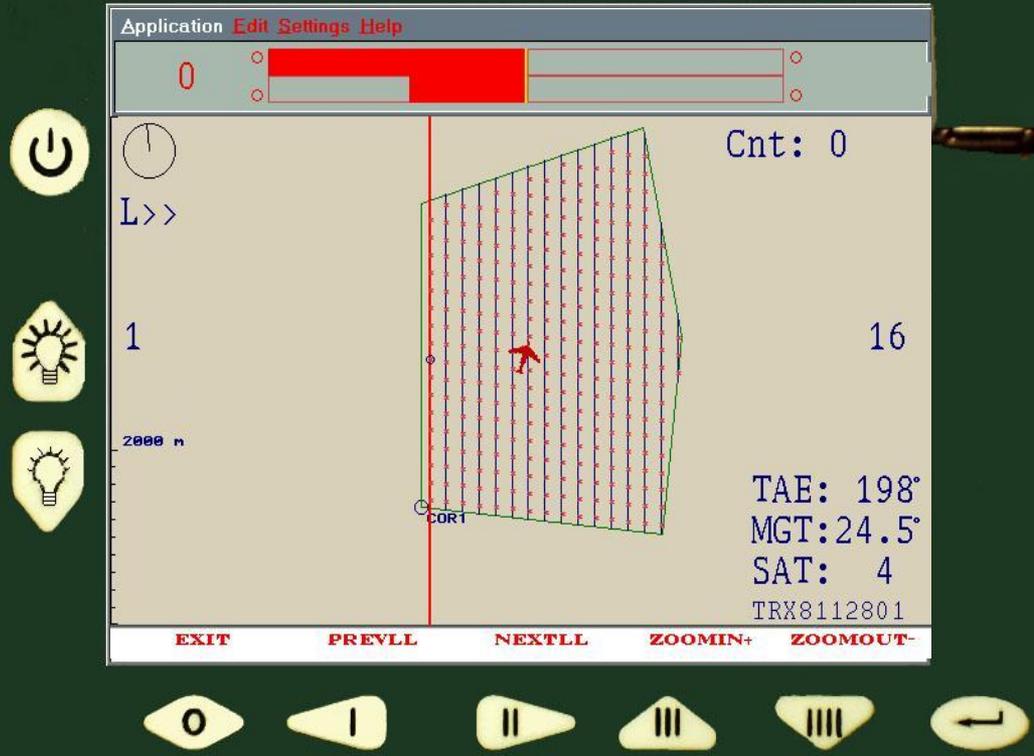
- Moving map display
- GPS receiver
- Light bar
- Camera triggering cables

For 3D guidance, you may need a laser altimeter for level flying.

Navigation System

With GPS and computer technologies, AG-NAV developed aerial application technology to increase the accuracy of aerial photogrammetry.

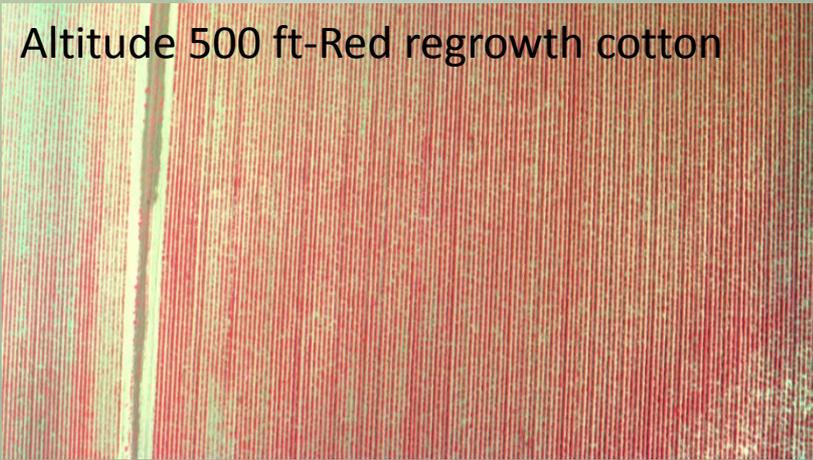
Ag-Nav Guía



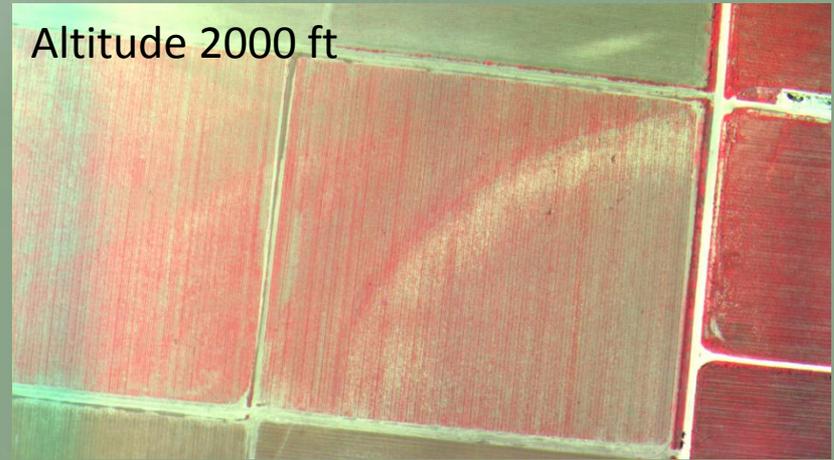
Typical Display of PhotoNav System

Images Taken with PhotoNav System

Altitude 500 ft-Red regrowth cotton



Altitude 2000 ft



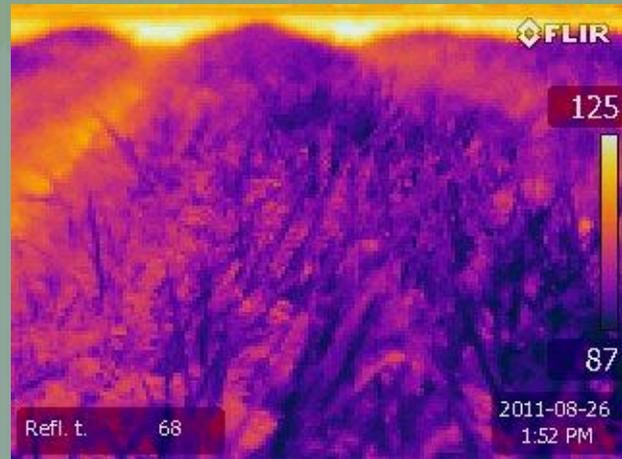
Rice field in Sour Lake, TX



Field plot area with sheath blight disease

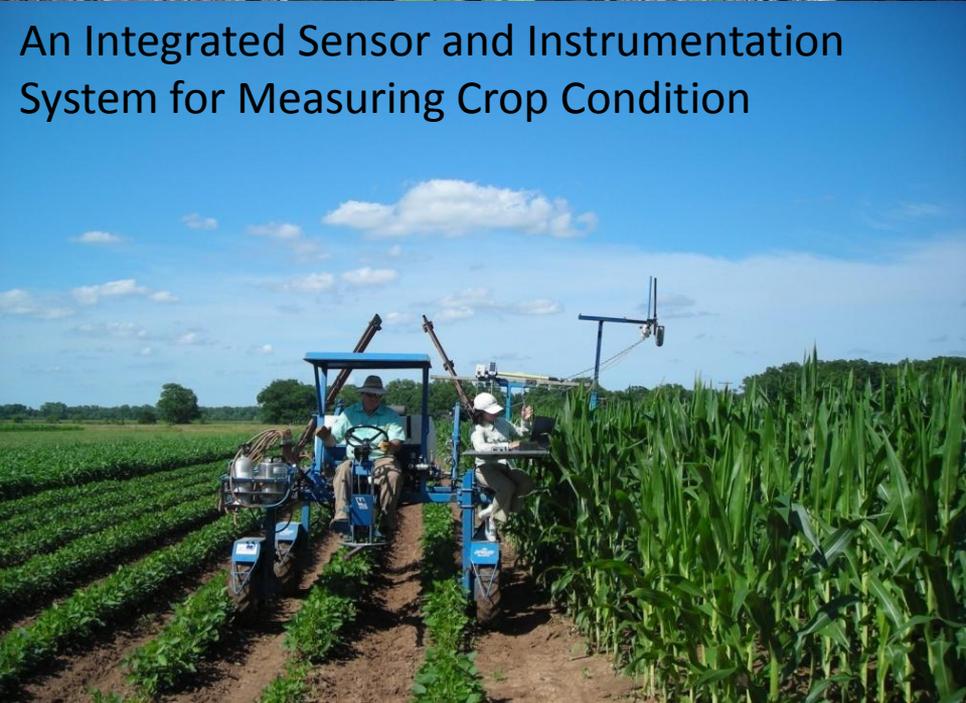


Ground-truth Measurements





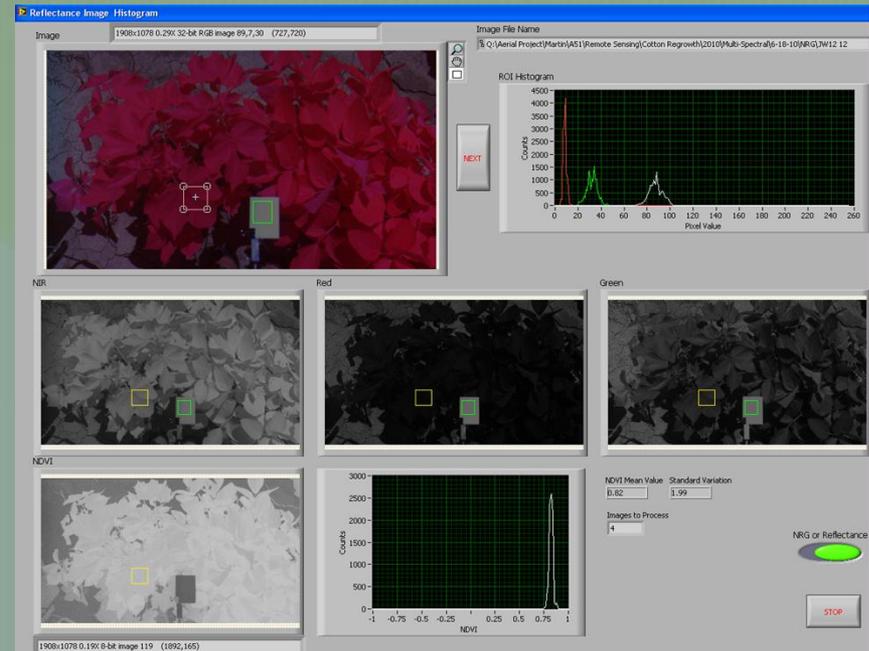
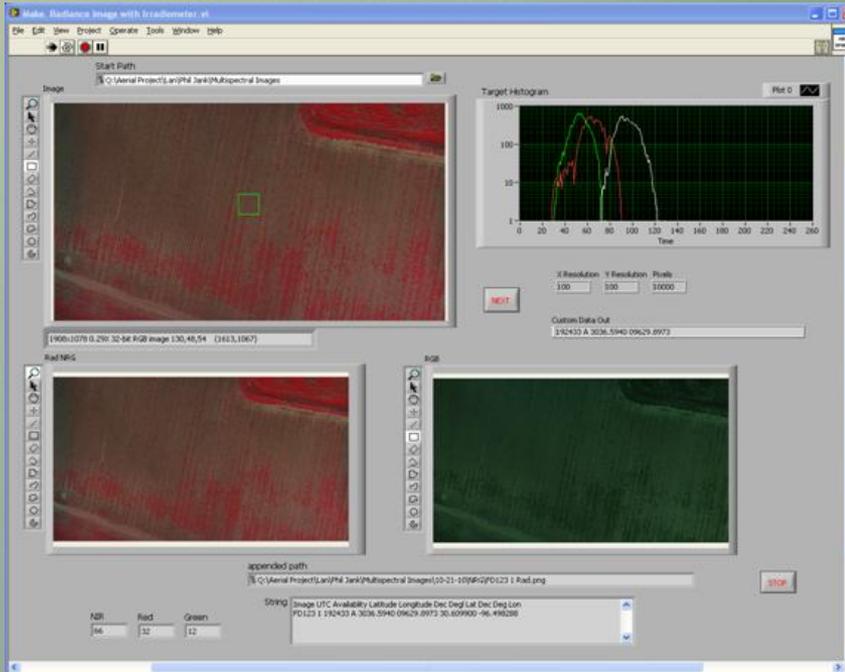
An Integrated Sensor and Instrumentation System for Measuring Crop Condition



A Spectral Sensing System for Measuring Crop Condition

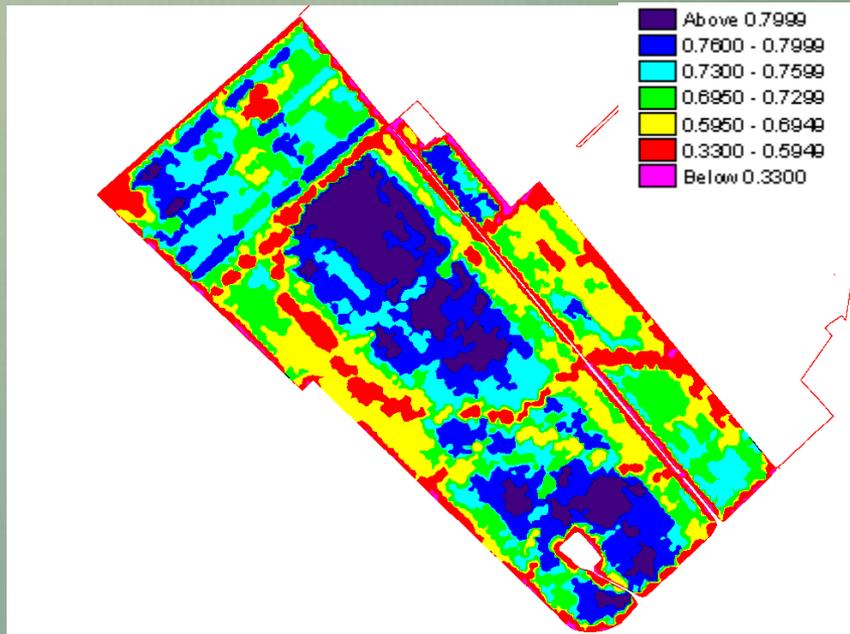


Rapid Imaging Analysis Software (RIAS)

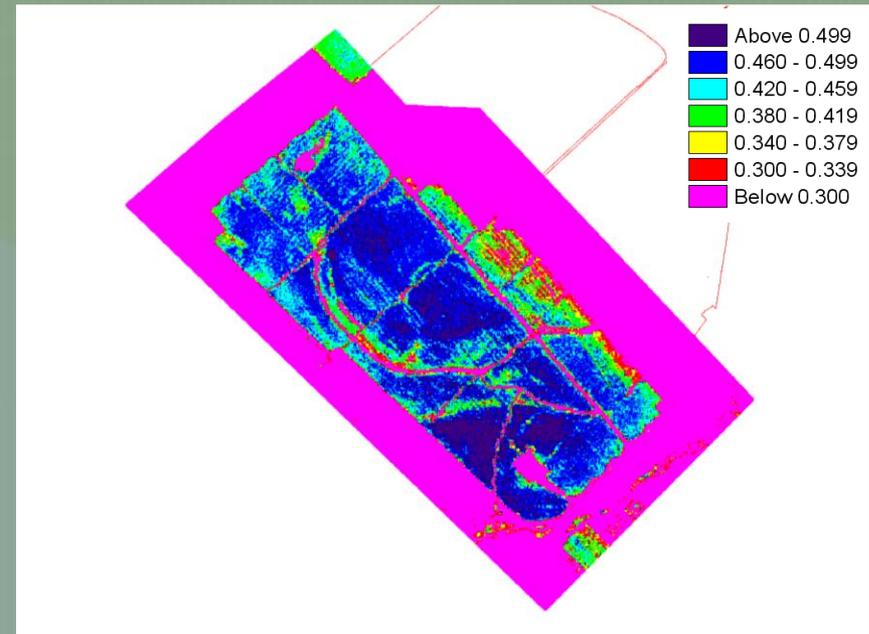


NDVI and Prescription Map

Ground-based GreenSeeker NDVI



Spatial NDVI



Variable Rate Aerial Application

- Variable rate technology is focused on applying pesticides, planting seeds, herbicides, soil amendments, plant growth regulators and fertilizers at various rates at a specific location

Variable Rate Aerial Application System

Two main components

- GPS
- Variable Flow Control System
- Commercial products-Hemisphere GPS, DelNorte System, Houma Avionics AutoCal II, etc.

Hemisphere GPS-IntelliStar



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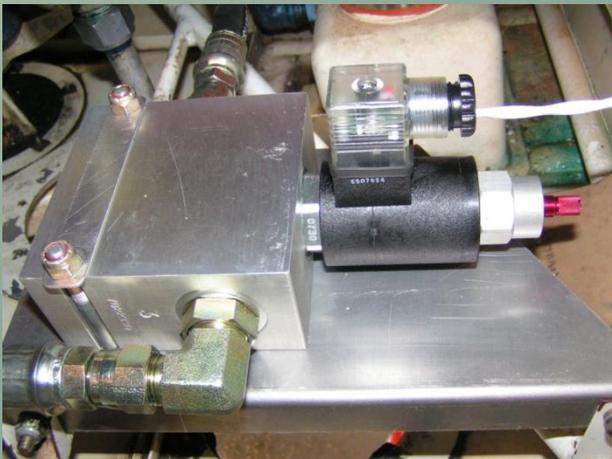


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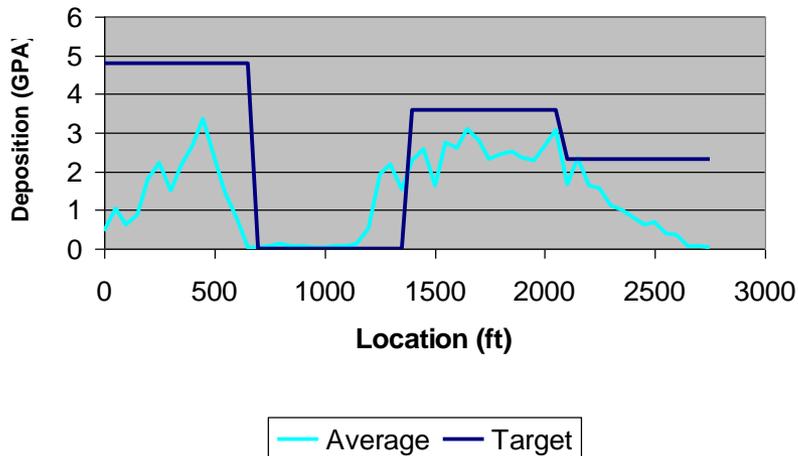
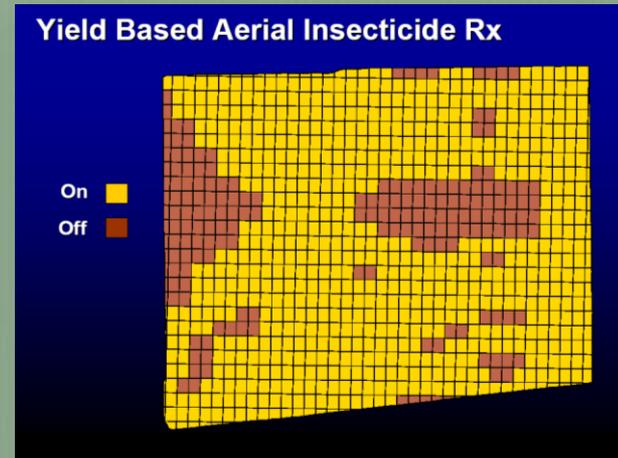


Air IntelliStar

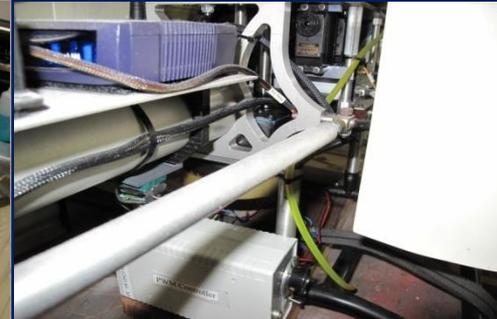
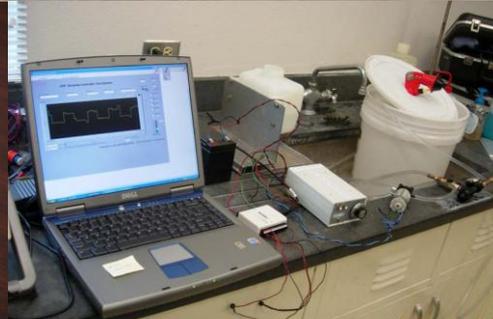
DelNorte System



A Computer-Controlled Spraying System for Aerial Application



PWM Sprayer Controller System for UAV



Future Directions

Real Time Image Processing

- To bridge the gap between remote sensing and variable-rate aerial application
- To develop a user-friendly image processing software system, aiming to analyze the data rapidly from aerial images

Future Directions

(continued)

- To look for a rapid, near real-time method for image analysis, georectification, and conversion
 - The idea is to remotely sense the field variable on one pass and apply the prescription on the next pass

Future Directions (continued)

VRT System

- Economical and user-friendly
- Variable rate aerial nozzles

Future Directions

(continued)

Multi-sensor Data Fusion Technology

- Multi-spectral, multi-temporal, multi-resolution remotely sensed data
- New data-fusion algorithms, architectures, and solutions

Summary

- These research projects demonstrate that precision agriculture technology has the potential to benefit the industry by saving operators and farmers' time and money
- Challenges to
 - Industry-user friendly and economic products;
 - Scientists-evaluate new RS and VRT products and also develop some new systems.

USDA ARS

Aerial Application Technology Team

Website: apmru.usda.gov/aerial



Thanks!

Yubin.lan@ars.usda.gov

-- WORKING FOR APPLICATORS --