Precision Agriculture and Precision Conservation

Dimitris Zermas[1], David Mulla[2], Daniel Kaiser[2], Ce Yang[2], Mike Bazakos[1], Vassilis Morellas[1], Nikolaos Papanikolopoulos[1]

[1]Center for Distributed Robotics and [2]Department of Soil, Water, and Climate (Precision Agriculture Center)

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Project Rationale

Minnesota Agricultural Statistics

- $700 million/yr for nitrogen fertilizer (700,000 tons)
- $4.2 billion corn yield/yr (1.18 billion bushels)

Issues

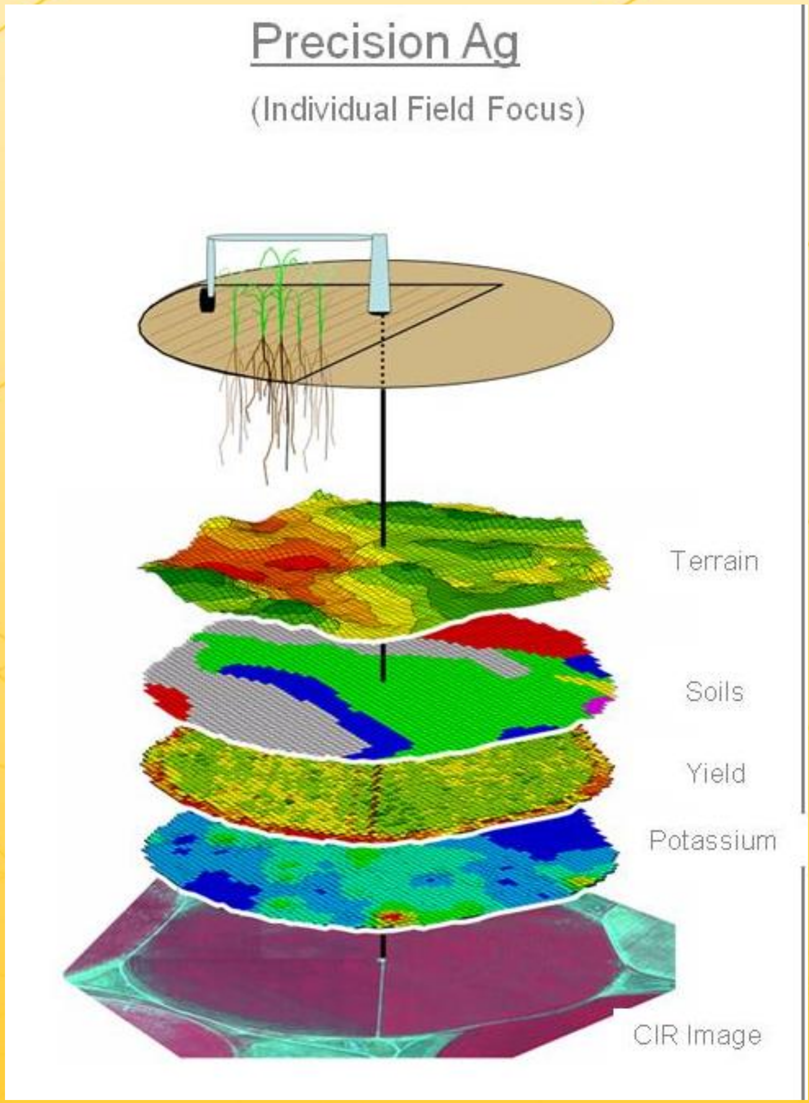
- Excess nitrogen pollutes surface and ground water
- 20% yield loss because of nitrogen deficiency

Goals

- Improve water quality (i.e. the Mississippi river)
- Reduce nitrogen fertilizer
- Improve crop yield (gain $835 million)

Precision Agriculture

- A management practice applied at the right rate, right time and the right place.
- Field sub-region management
  - Nutrients
  - Drainage or Irrigation
  - Pests and Weeds
  - Tillage and Seeding Operations



Benefits of Precision Agriculture

- Increased Profitability
  - improved efficiency of inputs
  - improved yield and quality of crop
- Reduced Risk
- Protection of the Environment

- Use of UAVs in Minnesota agriculture could lead to a thousand new jobs and nearly $150 million being pumped into the economy (Dept. Employment Econ. Development)

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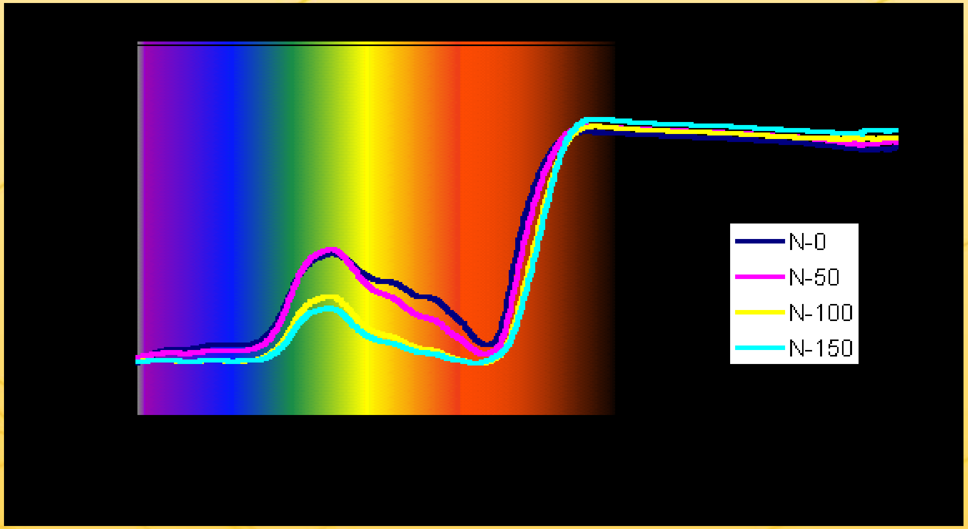
Robots in Precision Agriculture

- Unmanned aerial vehicles (UAV)
- Unmanned ground vehicles (UGV)

Properties of N Deficient Plants

- Green reflectance increases
- Red reflectance increases & NIR reflectance decreases
- Differences in reflectance greatest between 550 – 600 nm, followed by red-edge (680 – 730 nm)

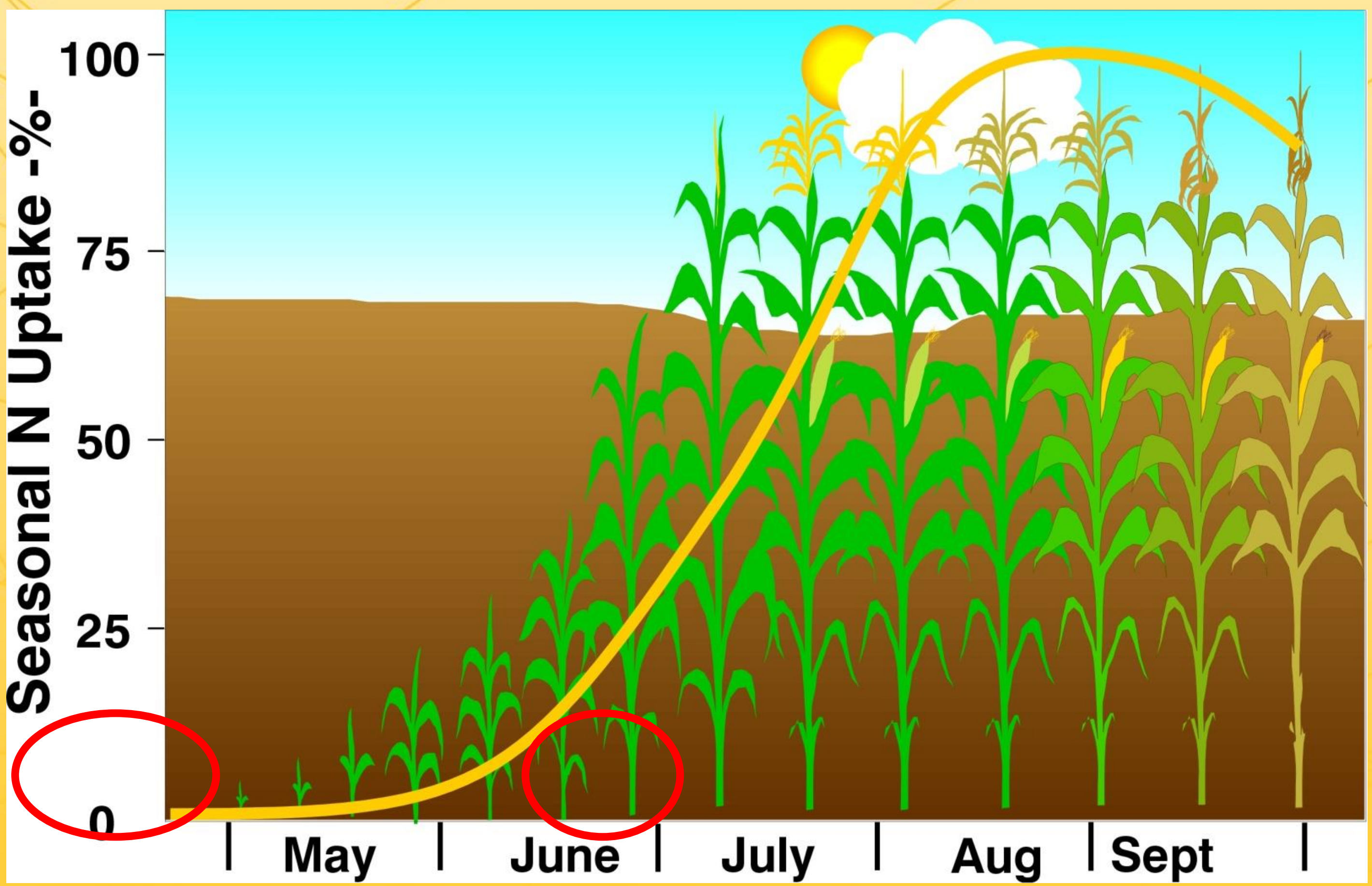


- **Nitrogen Sufficiency Index (NSI)**

$$NSI = \frac{\text{Leaf N, or Spectral index}}{\text{Reference value}} \times 100\%$$

Precision Variable Rate Nitrogen Management (VRN)

Dynamic In-Season N Management



(From J. Schepers, 2005)

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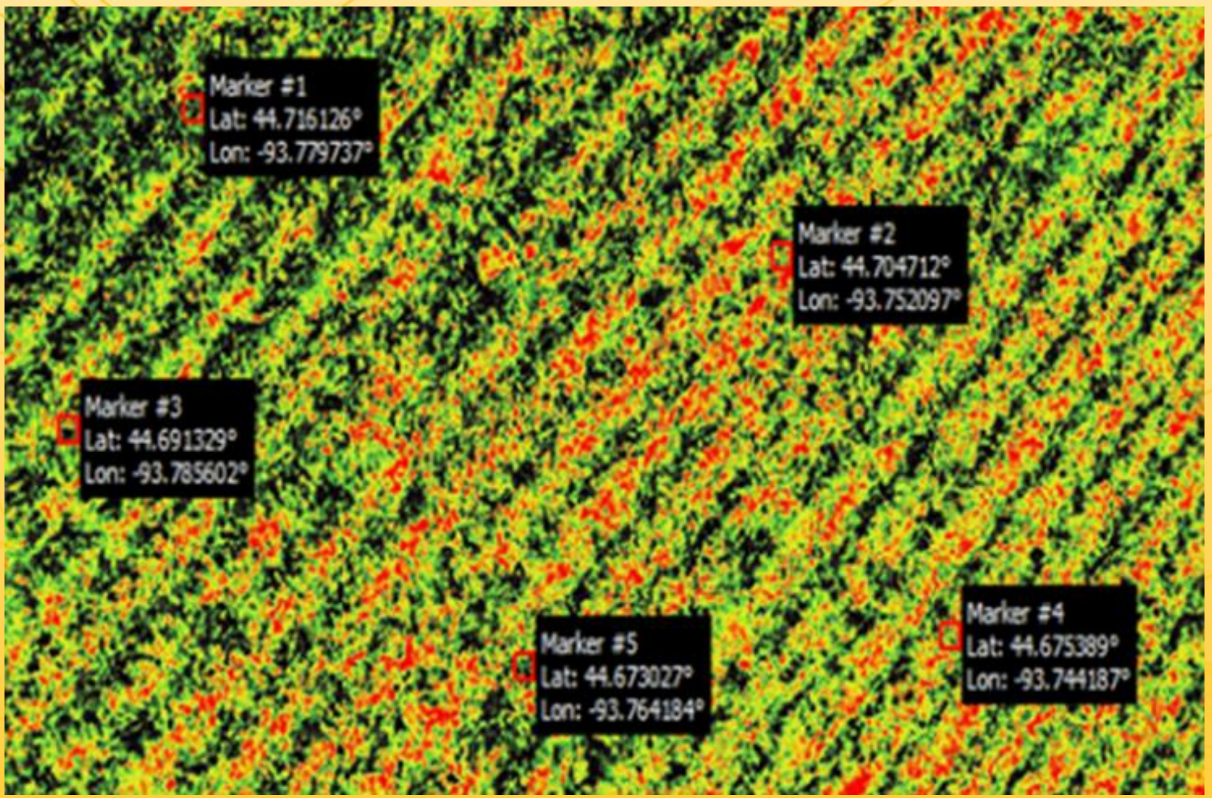
Problem Definition / Motivation

Automate corn field surveillance for the early detection and in-season treatment of crop nitrogen stress.



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Methodology

1. Detect potential stressed areas
2. Identify areas with nitrogen deficiency
3. Determine stress severity

Healthy

Nitrogen Deficient

Low Altitude Imaging

- High resolution images provide a close up view of the plants and their foliage, allowing a diagnosis of the type and severity of crop deficiency

Image of healthy plants

Image of N deficient plants

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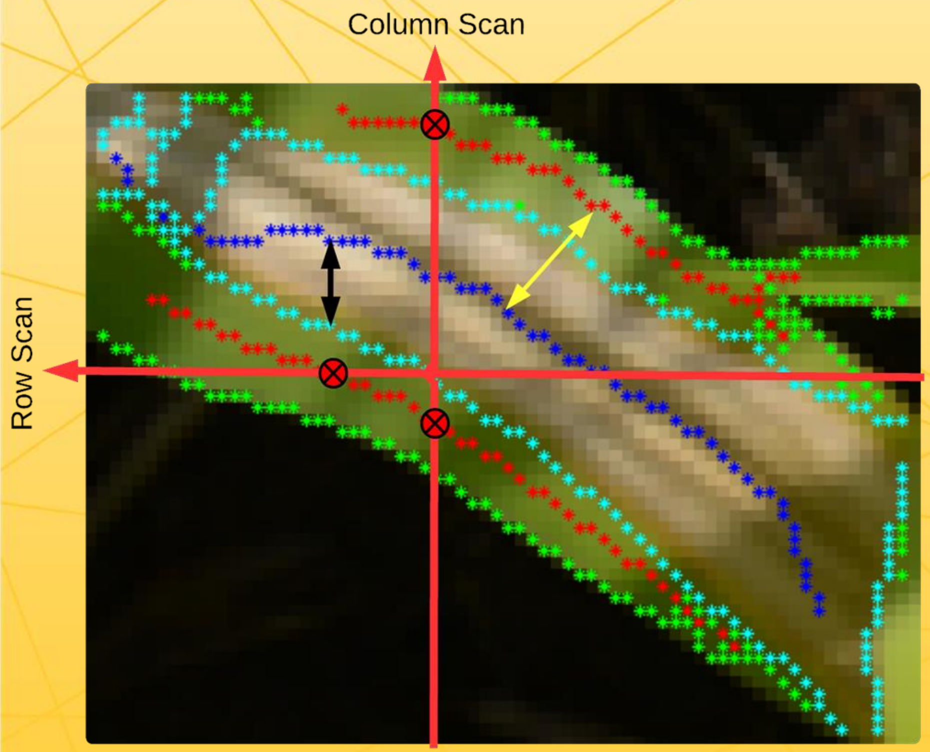
High Resolution Approach

Fly low and pay attention to the details!



Corn Leaf Analysis **N Stress Detection**

Commercialization

- We are discussing commercialization of our research with several Minnesota companies that focus their business on ground robots, software, or sensors

Conclusions

- Precision agriculture has exhibited enormous growth around the world since its beginning in the mid-1980's
- This growth was driven by technological advances associated with the growing availability of computers, geographic information systems, global positioning satellites and remote sensing
- Precision agriculture will continue to grow because of new innovations in robotics, leading to economic expansion and new jobs

Acknowledgements

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Thank you!

Questions?

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