UAS applications in agriculture

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Introduction

- Challenges for farmers
- UAV’s in agriculture
  - Literature search
- Examples
  - Haus Riswick
  - Grass parcel Reusel
- UAV usage in agriculture
  - Translation sensor result to action
  - Resolution
- What needs to be done?
Challenges when farming

- Clouds
- Sunlight
- Climate
- Crop
- Soil

Farmer management, e.g., fertilization

Chemical, physical, biological
Challenges farmers

- Reasonable income
- “Sharing the land”: agriculture, environment, recreation
- Fertilization
- Plant protection

Possible solution:

- Increasing nutrient use efficiency
  - Applying the right amount at the right time and the right spot

Precision farming
Precision farming

- Site specific management
  - No longer parcel/company based

- “on-the-fly” management
  - ‘Measurement’ at the front, ‘action’ at the rear

⇒ New techniques needed
Agricultural machinery with gps

- Plowing
- Planting/seeding
- Spraying
- Weeding
- Fertilization
- Irrigation
- Harvesting
Farmers actions

- Variable seeding
- Variable planting of potatoes
- Variable rate of application
  - fertilization
  - plant protection
- Estimating yield
- Estimating grass quality using sensors
  - for determining time of mowing/grazing
Information needed for site specific management

For each parcel:

- Variation in crop status ➔ integration of:
  - Soil characteristics
  - Crop characteristics
  - Weather
  - Management

This information is needed for action by the farmer:

- What to do?
- Where to do it
- How much?

Made to measure

Appropriate decision support system
Precision farming

Phases
1. Data collection
2. Field variability mapping
3. Decision making
4. Management practice

Remote sensing

Zhang, Korvacs, 2012
Sources of information ➔ sensing

- Remote sensing
  - satellite images
  - Uav ??

- Near sensing
  - Greenseeker
  - Crop Circle/OptRx
  - Yarasensor
  - Fritzmeier Isaria
Remote and near sensing

Remote sensing

- covers the parcel
- covers the parcel
- clouded: no image
- resolution (10x10 m)
- no request for image possible

+ large surfaces
+ relatively cheap
+ covers the parcel
+ resolution (10x10 m)
- clouded: no image
- no request for image possible

UAV

+ covers the parcel
+ no effects of clouds
+ image on request
+ resolution (1 x 1 m)
- not possible at high winds
- relatively expensive

Sensors on tractor or handheld

+ image on request
+ self management
- need to buy sensors
- measures parts of parcel
- data analysis: do it yourself
UAV’s in literature -1

2 databases searched,

- **Scopus**
  - Search terms: UAV, agriculture; subject area: agricultural and biological sciences
  - 42 papers found

- **Web of science**
  - Search terms: UAV agriculture
  - 40 papers found

- In total 62 papers
UAV’s in literature -2

- Subject of the papers:
  - Technology: 34 > 50%
  - Crop recognition: 5
  - Yield/biomass: < 10

- Crops
  - 36 of 62 papers cover crops
  - Vineyard: 6
  - Orchards: 5
  - Wheat: 5
  - Trees: 5
UAV’s in literature -3

- Lots of information about technology
- Hardly any about application/usage
  - What does the farmer need to do?
- More data are needed to determining usage of uav images in agriculture
- Decision support system is needed!
Example 1: Haus Riswick

- **Field set-up:**
  - 60 agricultural fields
  - 4 x 15 different treatments

- **Sampled:**
  - 4 x 6 increasing chemical fertilization (KAS)
  - 4 x 3 increasing organic fertilization (OM)
Haus Riswick: Octocopter set-up

- Image taken October 2012
- Weather
  - 100% overcast
  - Not ideal for RS
- Equipped with multi-spectral ‘tetracam’ camera
  - Green channel (520 – 600 nm)
  - Red channel (630 – 690 nm)
  - NIR channel (760 – 900 nm)
Haus Riswick: other activities

- Cropscan measurements
- Fieldspec measurements
- Grass harvesting
Results 1: NDVI-values

- NDVI tetracam < NDVI fieldspec
- NDVI tetracam < NDVI cropscan
- NDVI cropscan > NDVI fieldspec

Different sensors → same index → different values
Results 2: yield estimation

- Yield shows N-treatments
- NDVI-tetracam relationship with yield
  - KAS: reasonable $R^2$
  - OM: terrible $R^2$
  - More data are needed
Results 3: Nuptake and vegetation index

- Best relationship found with cropscan
- Relationship for UAV data reasonable
Example 2: grass parcel Reusel

UAV image
- 5 juni 2012
- Tetracam
- Terrasphere

WDVI
Example 2: other activities

- Measurements with cropscan
  - bi-weekly
  - Including 14 Juni 2012
- Harvesting
  - 2e cut 23 Juni 2012
Results 2: N-uptake

- Derived with Cropscan
- Good relationship WDVI – N uptake
Results 2: predicted N uptake

Prediction of N uptake:
- Cropscan: RMSE = ok
- UAV: RMSE = not good
Result 3: relation with yield

- Uav image: 5 juni 2012
- Harvesting: 23 juni 2012
- No prediction possible
UAV’s – challenges

- Relationships VI’s - crop status (N-uptake) are derived with the cropscan
- For different grasslands: best vegetation index differs
  - Haus Riswick: NDRE
  - Grass parcel Reusel: WDVI780
- Indices uav differ with cropscan indices
  - Tetracam → limited indices
  - Hyperspectral camera’s
    - several indices can be derived
    - Relationships with cropscan needed
UAV usage in agriculture

- Beautiful images are available
- Farmers want to know what to do where
- Causes of variation are often unknown
- What to recommend the farmer?

- Important for acceptance of UAV images
  - Decision support system
    - Monitoring
    - Recommendation
    - Recalculation to required resolution
      - Equipment depended
  - Low cost
  - Quick delivery
What can we do?

- Images show variation in parcel
- Crop integrates the environment
- Use images for monitoring crop together with farmer

Different potato varieties

Donald

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What to do next?

- Work on data
  - Combine
    - different sensors
    - different fields
    - different years
- Find robust VI’s
- Find robust relationships VI’s – crop status
Questions??