AUTOMATIC REMOTE IMAGE PROCESSING FOR AGRICULTURE USES THROUGH SPECIFIC SOFTWARE


Institute for Sustainable Agriculture (CSIC), Cordoba, Spain

11th ICPA, Indianapolis, IN, 15-18 July 2012
AUTOMATIC REMOTE IMAGE PROCESSING FOR AGRICULTURE USES THROUGH SPECIFIC SOFTWARE

Content

1) Powerful image processing programme (*ENVI*, *ERDAS*, others)

2) Complementary/ specific modules are **NEEDED for Agriculture/ Precision Agriculture** (why?/ which?)

3) **Specific ENVI modules** (“add-on) developed by IAS-CSIC
   3a. Orchards trees assessment (CLUAS®)
   3b. Herbaceous crop assessment (SARI®)
   3c. Cropping systems classification (CROPCLASS®) and parcel isolation (CROPCLASS++, under development)
   3e. Automatic image georeferentiation/ co-registration AUGEO-2.0®
   3f. Semi-automatic modules integration (SAMI, under development)

4) **AIM:** to contribute to the automatic designing of agricultural operations through remote images, ENVI and new specific “ENVI-add-on”

5) **Projects, publications, registrations and patents (IAS/ CSIC)**
Remote sensing:

Very useful for agriculture and environment studies
Highly informative
Economically feasible at large and reduced scale

**ONLY IF IMAGE PROCESSING IS FULLY AUTOMATED**
(adequately managed through specific menus)
AUTOMATIC REMOTE IMAGE PROCESSING FOR AGRICULTURE USES THROUGH SPECIFIC SOFTWARE

AIM

To contribute to automate the design of agricultural operation through remote sensing images

WHICH agricultural operations?: ALL, seeding, fertilization, herbicide application, etc.

WHAT IS NEEDED?

Specific modules (add-on) to complete and automate ENVI image processing

Any remote image can provide potentially tremendous amount of information for farmers, however its processing, sectioning and assessment at reduced scale (micro-parcel, micro-plot scale) is needed:

To provide useful/ manageable information
To achieve the processes economically feasible to be used for farmers......
1) ENVI/ Interfaces: many processing options.... But lack specific menus for agricultural...
2) ENVI/ Interfaces: many processing options. But it lacks specific menus for agricultural uses…

…so we solved this inconvenience by adding our own tools.
SAMI (Semi-Automatic modules integration) Flowchart
4. Precision Agriculture through remote sensing
(sophisticated technology, environmental-friendly, and economics)

a) Spatial variability of biotic (weed patches) and abiotic (nutrient, water) factors

b) Biotic/ abiotic map
c) Treatment map
d) Variable rate application equipment
e) Site-specific treatments (micro-plots)
3) **Specific ENVI modules ("add-on") developed by IAS-CSIC**

3a. Orchards trees assessment (CLUAS)

3b. Herbaceous crop assessment (SARI)

3c. Cropping systems classification (CROPCLASS)

3d. Isolation of individual agricultural parcel (CROPCLASS++)

3e. Automatic image georeferentiation/co-registration AUGEO-2.0

3f. Semi-automatic modules integration (SAMI, under development)
AUTOMATIC REMOTE IMAGE PROCESSING FOR AGRICULTURE USES THROUGH SPECIFIC SOFTWARE

3a) Software CLUAS® for Orchards trees assessment
(Clustering assessment)

To assess quantitative agronomic and environmental indicators of trees.

Neighbouring pixels within a range of digital values are integrated into groups of defined size.

Each one of those groups is processed as a unit known as “cluster”, representing a single tree.

3a. Software CLUAS®: Assessment of land uses in tree orchards (at tree and parcel level)

<table>
<thead>
<tr>
<th>Plot</th>
<th>Area (ha)</th>
<th>Olive trees (%)</th>
<th>Vegetat. Cover (%)</th>
<th>Bare soil (%)</th>
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<tbody>
<tr>
<td>A</td>
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<td>50.1%</td>
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<td>38.0%</td>
<td>47.1%</td>
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</table>

IAS- CSIC.
Peña-Barragán et al. 2005, Agric., Environment & Ecosystems

3b. Software SARI® to define and assess “micro-plots”

Microplot length and height is arbitrarily defined.
Indicators calculated by SARI:
- Integrated pixel digital values (IDV)
- Percentage of pixels (%PI) with DV ≠ 0
- Classify the microplots in defined classes

Precision Agriculture (Gomez-Candón et al., 2012a & 2012b)
To design any agricultural operation at farm/parcel level

(Outcome: input parcel prescription map)

3b. Software SARI®, Sectioning & Assessment of Remote Images, Precision Agriculture (Gomez-Candón et al., 2012a & 2012b)
3c. Cropping systems classification (CROPCLASS®)
(Specific ENVI module, “add-on”)

- Multi-temporal classification of crop fields.
- User-defined plot size and geometry.
- Import/export related only to georeferenced coordinates.
- Spatial and digital information retrieval from each plot.
- Reports for each plot and the image as a whole.

(García-Torres et al. CROPCLASS®, March 2011)
3c. Software CROPCLASS®: to automatically isolate, classify and analysis each parcel

(García-Torres et al. CROPCLASS®, March 2011)

High spatial resolution, multispectral and multi-temporal series of images

1) Plot/parcel isolation
2) Assessment and export of digital values
3) Analysis and interpretation of “its” agricultural status
4) Export of the information generated
A) Primary Process of Multi-temporal images

Loading

Image 1  Image 2  Image 3  Image N

Georeferencing

Hard-edge points

External Terrestrial Signals (AUGEO 2.0 ®)

Image to Image
A) Primary Process of Multi-temporal images

Calibration

Original

Image 1           Image 2           ......           Image N

Calibrated

RIC Software
B) Secondary Process: Whole Image Agronomic Characteristics

- Biomass
- Leaf Area
- Stress Zones
- Chlorophyll
- Diseases Patches
- Nitrogen Content
- Weed Patches
- Others

C) Agricultural Parcel Isolation

- Parcel definition files (creation, import)

Isolation of individual parcels in a multitemporal series

Image 1  Image 2  Image 3  Image 4  …..  Image N
D) Sectioning individual parcels

**Orchards**

CLUAS ® / Tree assesment

**Herbaceous Crops**

SARI ®
E) SAMI achievements

- A geographic point
- Parcel to which it belongs

- Temporal series of the selected parcel

- Qualitative data of selected parcel

<table>
<thead>
<tr>
<th></th>
<th>Img 1</th>
<th>Img 2</th>
<th>Img 3</th>
<th>Img 4</th>
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<td>0,782</td>
<td>0,983</td>
<td>...</td>
<td>0,932</td>
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</table>
3e Automatic image georeferencing/ co-registration AUGEO-2.0®
(Specific ENVI module, “add-on”)

- Only ATT’s within a defined range are mutually detected.
- Different colors work as a filter.
- Minimum and maximum distance

(Gómez-Candón et al. 2011. *Precision Agricul.*, 6, 876-891)
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3f. SAMI: Automatic Module Integration (under development)

- All previous modules compiled into one add-on.
- Execution as a sequence.
- Outputs from one module could serve as input data to another.
AUTOMATIC REMOTE IMAGE PROCESSING FOR AGRICULTURE

1) PREPROCESSING
   1a) Geo-referencing / Co-registration
   1b) Calibration

   Image 1
   Image 2
   ......         Image n

2) CROPPING SYSTEM CLASSIFICATION AND ISOLATION (CROPCLASS)
   Parcel Definition
   Isolated Parcels

3) IMPLEMENTATION OF PRECISION AGRICULTURE
   CLUAS (Orchard Trees Assessment)  SARI (Herbaceous Input Prescription map)

4) SITE-SPECIFIC CROP INDEXES AT MICRO PLOT LEVEL
   - Biomass
   - Leaf Area
   - Stress Zones
   - Chlorophyll
   - Diseases Patches
   - Nitrogen Content
   - Weed Patches
   - Others
FINAL COMMENTS

-- IT IS NEEDED TO INCORPORATE SPECIFIC MODULES FOR AGRICULTURE/AGRI-ENVIRONMENT STUDIES

-- OTHERWISE REMOTE SENSING WILL NOT BE ECONOMICALLY FEASIBLE FOR PRECISION AGRICULTURE USES

Our add-on are free for research groups upon request

THANK YOU FOR YOUR ATTENTION
AUTOMATIC REMOTE IMAGE PROCESSING FOR AGRICULTURE USES THROUGH SPECIFIC SOFTWARE

5) Publications, registrations, patents and projects (IAS-CSIC)

Projects (Spanish Ministry of Science & Innovation)
AGL2010- 15506 (2011-2013)

Papers
-- CLUAS®, Computers & Elect. in Agriculture, 2008, 61, 179-191
-- AUGEO-2.0®, Precision Agriculture 2011, 6, 876-891
-- SARI®, Precision Agriculture 2012, 3, 322-336,
-- SARI®, Precision Agriculture 2012, 3, 337-350

Registration
CLUAS® (2008)
SARI® (2008)
AUGEO-2.0® (April 2010)
CROPCLASS® (March 2011)

Patents:
CLUAS PCT/ ES2008/07001·
SARI P200801932/ Nº ES 2 332 567