Automatic image processing for agriculture through specific ENVI modules (add-on)

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Automatic image processing for agriculture through specific ENVI modules (add-on)

Content

1) ENVI, a powerful image processing software

2) Complementary ENVI 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 geo-referencing/ co-registration AUGEO-2.0®
   3f. Automatic modules integration (AMI, under development)

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

5) Publications, registrations and patents by IAS/ CSIC
Remote sensing images:

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)
Precision Agriculture through remote sensing

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)
**AIM**

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

**WHICH operation?: 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......
ENVI/ Interfaces: many processing options. But it lacks specific menus for agricultural uses…

…so we solved this inconvenience by adding our own tools.
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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. Automatic modules integration (AMI, under development)
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3) Specific ENVI modules (“add-on): Orchards trees assessment (CLUAS®)

- Designed to determinate 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.
• **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. Cov (%)</th>
<th>Bare soil (%)</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>5.23</td>
<td>24.6%</td>
<td><strong>50.1%</strong></td>
<td>25.2</td>
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<tr>
<td>B</td>
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<td>6.7%</td>
<td><strong>61.1%</strong></td>
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<tr>
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<td>40.9%</td>
<td><strong>54.2%</strong></td>
<td>5.6</td>
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<tr>
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<td><strong>67.4%</strong></td>
<td>0.4</td>
</tr>
<tr>
<td>E</td>
<td>4.31</td>
<td>38.0%</td>
<td><strong>47.1%</strong></td>
<td>15.0</td>
</tr>
</tbody>
</table>

IAS- CSIC.
Peña-Barragan et al. 2005, Agric., Environment & Ecosystems
3) Specific ENVI modules ("add-on): Herbaceous crop assessment (SARI®)

- SARI® splits an image into grids of rectangular micro-plots.

- It calculates different indicators for each micro-plot, including the integrated pixel digital values.

- The output includes geo-referenced and visual herbicide prescription maps, which could be used with variable-rate application equipment.
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
Software SARI®, Sectioning & Assessment of Remote Images, PRECISION AGRICULTURE

To design any agricultural operation at farm/ parcel level
(Input parcel prescription map)
3) Specific ENVI modules ("add-on"): Automatic image geo-referencing/ co-registration AUGEO-2.0®

- Geo-referencing usually needs the existence of hard-edged points.

- Limitation is solved by using Artificial Terrestrial Targets (ATT’s).

- Semi-automatic detection of those ATT’s placed in pairs.

- Spatial and digital information about the targets, shown as ROIs and an output file.
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3) Specific ENVI modules ("add-on"): Automatic image georeferencing/ co-registration AUGEO-2.0®

- Only ATT’s within a defined range are mutually detected.
- Different colors work as a filter.
- Minimum and maximum distance
Hard-edge points are difficult to find.
More time-consuming

Better accuracy
Less time-consuming

Hard edge points.
Artificial Terrestrial Targets
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3) Specific ENVI modules (“add-on): Cropping systems classification (CROPCLASS®)

- 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.
Software CROPCLASS®: to automatically isolate, classify and analysis each parcel

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
Software CROPCLASS®: to automatically isolate, classify and analysis each parcel
3) AMI: 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.
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5) Publications, registrations and patents by IAS-CSIC

Papers:
--CLUAS®, Computers & Electronic in Agriculture, 2008
--AUGEO 2.0®, Precision Agriculture 2011
--SARI®, Precision Agriculture 2011 (in print)
--SARI®, Precision Agriculture 2011b (in print)

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

Patents:
CLUAS PCT/ES2008/07001
SARI P200801932/Nº ES 2 332 567
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Thank you for your attention