Detecting plant parts of sweet-pepper using pixel classification and post-processing

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Objectives
- Detect plant vegetation in a crop row
- Classify vegetation into 5 classes
  a. Stem (hard obstacle)
  b. Green Fruit (hard obstacle)
  c. Top of a leaf
  d. Bottom of a leaf
  e. Petiole (soft obstacle)
- Perform post-processing for green fruit detection

Background
A sweet-pepper harvesting robot is under development within the CROPS project "Clever Robots for Crops". Plant parts must be detected and classified into hard (construction element, stem, fruit) and soft (leaves, petiole) obstacles for motion planning.

Materials and methods
Imaging wavelengths:
- 447 nm – bandwidth 60 nm
- 562 nm – bandwidth 40 nm
- 624 nm – bandwidth 40 nm
- 692 nm – bandwidth 40 nm
- >900 nm – longpass

Pixel-based Features
NDI; Entropy; PCA; SAM; Mahalanobis Distance

Data
- 12 scenes of sweet-pepper cultivar "Viper"
- 3 million labelled pixels

Classification
- Classification and Regression Tree (CART) and feature selection
- New 'robust-and-balanced accuracy' performance measure that uses the St. Dev. of true-positive detection rate among scenes

Conclusions
- Due to robustness criteria, classification standard deviation among scenes drops by more than 50% without significant loss in accuracy!
- In continuation research, object-based features will be added to improve classification accuracy
- Green fruit detection rate is comparable to the state-of-the-art

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