Spectral-spatial Classification in Hyperspectral Remote Sensing

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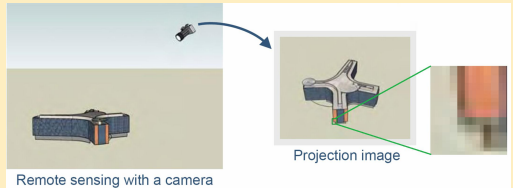**gipsa**-lab

HYPER i n e t

Remote sensing

- **Technologies** for gathering **data** and **information** by measuring signals from objects located **beyond the immediate vicinity of the sensor devices**.

- Allows to look beyond a human vision

- **Instruments:** cameras, radiometers, radio frequency receivers, radar systems, sonar, thermal devices, sound detectors, seismographs,…
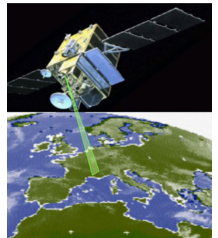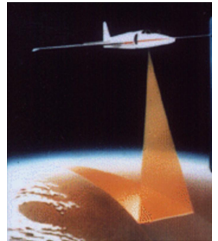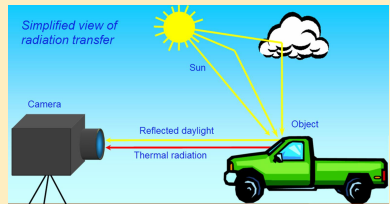
Spectral imagery

Spatial context

- 2D
- Digital image $\rightarrow$ composed of pixels
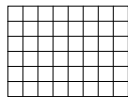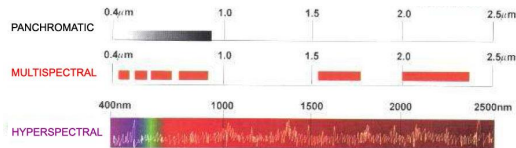

Remote sensing with a camera

Projection image

Spectral context
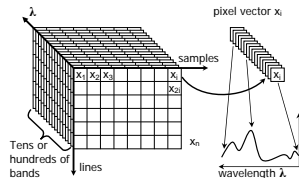
- Measurement of intensity of EM radiations (light)

Simplified view of radiation transfer

Sun

Camera

Reflected daylight

Thermal radiation

Object

Spectral context
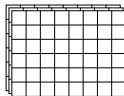
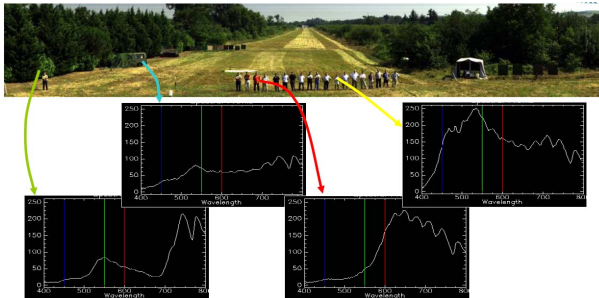| Panchromatic	Multispectral	Hyperspectral
• one grey level value per pixel	• 2-10 bands • limited spectral info	• tens or hundreds of narrow bands • detailed spectral info

Hyperspectral image

- Every pixel contains a detailed spectrum (>100 spectral bands)
- More information per pixel → increasing capability to distinguish objects
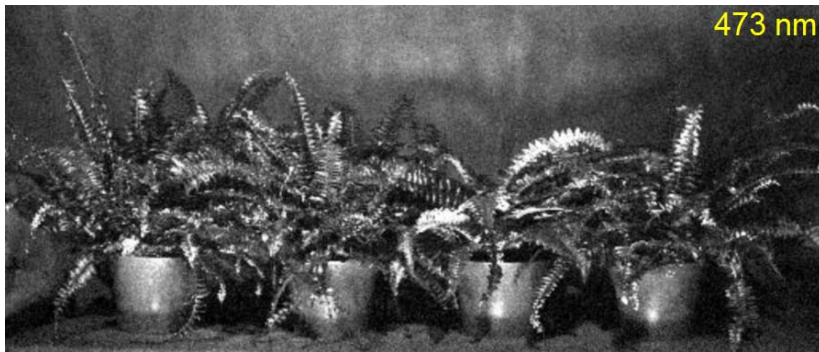
Example: why hyperspectral images are useful?

- Which of plants is artificial?

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- Which of plants is artificial?
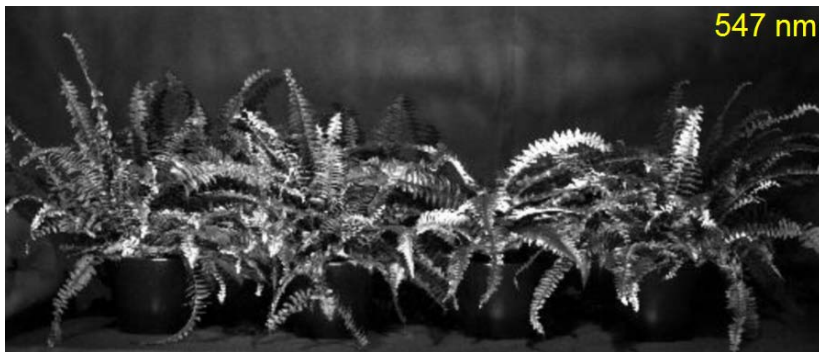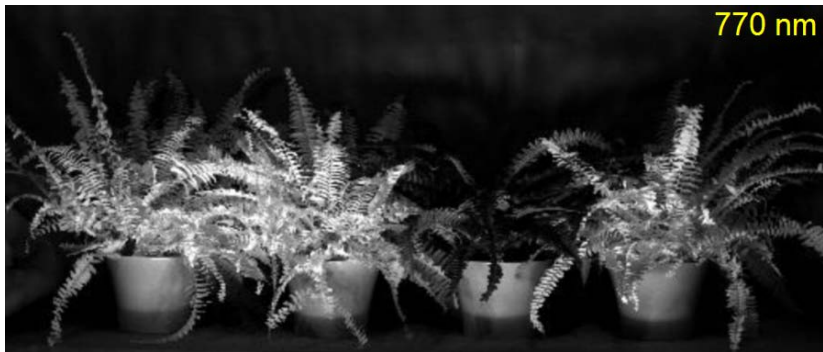
Example: why hyperspectral images are useful?
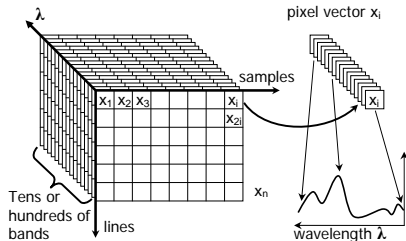
- Which of plants is artificial?

Example: why hyperspectral images are useful?

- Which of plants is artificial?

621 nm

Example: why hyperspectral images are useful?

- Which of plants is artificial?

Hyperspectral image
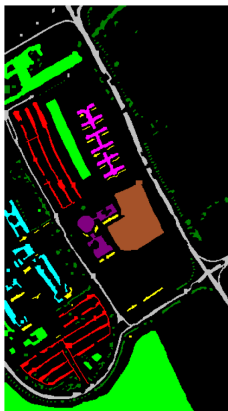
- Hyperspectral image cube
- High dimensionality

⇓

- Manual inspection: not a good idea
- Efficient algorithms for automatic processing are required!

Classification problem

Input HS image
[610 × 340 × 103]

Ground-truth data

Task

Assign **every**
pixel to **one**
of the **nine** classes:

alphalt

meadows
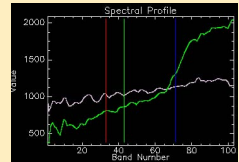
gravel

trees

metal sheets

bare soil

bitumen

bricks

shadows

Classification approaches

Only spectral information

- Spectra of each pixel is analyzed
- Directly accessible
- Variety of methods (e.g. SVM)
  $\rightarrow$ good classification results

$\Rightarrow$

alphalt
meadows
gravel
trees
metal sheets
bare soil
bitumen
bricks
shadows

Overall accuracy = 81.01%

Classification approaches

Only spectral information

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- Directly accessible
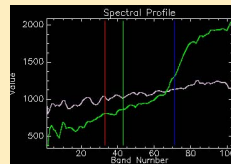- Variety of methods (e.g. SVM)
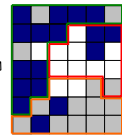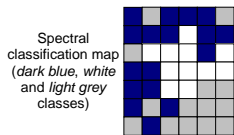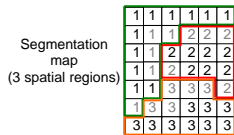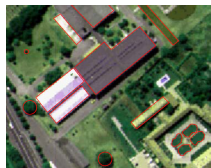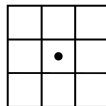 $\rightarrow$ good classification results

Spectral + spatial information

- Info about spatial structures included
- How to define structures?
  - fixed closest neighborhood
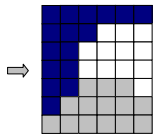 - adaptive neighborhood
    (segmentation map)

Spectral-spatial classification

- Fixed closest neighborhood
  - filtering using 8-neighborhood

- Adaptive neighborhood
  - segmentation - partitioning into homogeneous regions
  - majority vote

Segmentation map (3 spatial regions)

Spectral classification map (*dark blue*, *white* and *light grey* classes)

Combination of segmentation and spectral classification results (majority vote within 3 spatial regions)

Result of spectral-spatial classification (classification map after majority vote)

Spectral-spatial classification

- Adaptive neighborhood (segmentation map)

Result of spectral classification

Segmentation map (clustering using the EM algorithm)

Result of spectral-spatial classification

+ ⇒

Overall accuracy = 81.01%

Overall accuracy = 93.59%

Conclusions

- Work in progress!

Thank you for your attention!