Hyperspectral satellite imaging

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[1] *Digital imaging systems - 1MD130*

I. INTRODUCTION

- Spectroscopy of reflected light from earth surface
  - Passive technique
  - Materials characterized by spectral signature (Absorption and reflection)
  - Acquires images in many spectral bands so for each pixel a reflectance spectrum can be derived
  - Important absorption features occur in the 400-2500 nm band (reflected solar radiation dominates natural EMS)

I. INTRODUCTION

- Hyperspectral imaging used in many fields
  - Ecosystem processes
  - Surface mineralogy
  - Water quality
  - Soil type and erosion,
  - vegetation type and more...

I. BRIEF HISTORY

- +30 Years of hyperspectral satellite imaging
  - Landsat-1 - **1972 NASA/JPL** (multispectral)
    - Portable field reflectance spectrometers developed
  - For a long time was the spectral regions with atmospheric absorption seen as drawback
  - Better algorithms and hardware made it possible to correct for this
  - First commercial hyperspectral imaging systems for airborne use (DAIS **1989**)
  - EO1 - Hyperion sensor - **2000 NASA**
  - EnMAP - **2022 DLR**

- Used in research
- Drawbacks
  - Not easy to deploy

I. HOW IS THE IMAGE FORMED

- Sun the source of energy
- Sensor type:
  - Diffraction Grating Spectrometers
  - Prism Spectrometers
- Imaging:
  - Push-broom
  - Whiskbroom

I. WHAT PROPERTY OF THE SAMPLE IS IMAGED?

- Each material has a unique spectral characteristic
- Interaction radiation
  - Absorbtion - material and wavelenght
  - Reflection
  - Transmission

I. RESOLUTION AND SAMPLE SIZE

- Spatial resolution
  - Field-of-view (**FOV**)
  - Instantaneous-field-of-view (**IFOV**)
  - Ground-projected instantaneous-field-of-view (**GIFOV**)
    - depends on the satellite elevation and varies with the viewing angle
  - Across-track (ACT) and along-track (ALT) resolution
    - affected by integration time and smearing effects

I. RESOLUTION AND SAMPLE SIZE

- Spectral resolution
  - Portion of the **EMS** to which an instrument is sensitive
  - Hyperspectral imaging - hundred of channels
- Radiometric resolution
  - Ability of the sensor to register differences in radiation
  - Typically 8 and 12 bit, (EnMAP 14 bits)
- Temporal resolution
  - Time between two acquisitions
  - Depends on satelite orbit
  - Vary greatly depending on cloud coverege

- Trade off

In the relationship of spatial and spectral resolution, as one increases the other needs to decrease to gain the same amount of photons on the detector. That means you either get an image with high spectral but rather low spatial resolution (1), an image with high spatial but low spectral resolution (2) or something in-between (both medium resolution). Sensor design tries to avoid low SNR (3) and tries to achieve the best trade-off between spectral, spatial resolution and high SNR for a certain application.

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- topographic

I. COST AND LIMITING FACTORS

I. VARIANTS AND FUTURE USE

I. TITLE

II. REFERENCES