What is Hyperspectral Imagery (HSI)?

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Missouri Resource Assessment Partnership (MoRAP)
What is Remote Sensing?

- The science and art of obtaining information about an object, area, or phenomenon through the analysis of data acquired by a device that is not in contact with it

- Requires platform and sensor
Platform and Sensor
Why use Remote Sensing?

- Bird’s Eye View
- Large Area Data Collection
- Comprehensive Sampling
- Objectivity in Data Collection
- Repeatability / Intercomparability of Data
- High Temporal Resolution
Electromagnetic Spectrum

Wavelength (um) 10⁻⁶ 10⁻⁵ 10⁻⁴ 10⁻³ 10⁻² 10⁻¹ 1 10 10² 10³ 10⁴ 10⁵ 10⁶

UV blue green red Near-infrared

Visible

Cosmic rays Gamma rays X rays Ultraviolet (UV) Visible Mid-IR Near-IR Thermal IR Microwave Television & Radio

1 mm 1 meter
Electromagnetic Spectrum

- ‘Visible’ region very small
- Ultra Violet, Infrared (near, mid, thermal), microwave
- No clear-cut divisions
- Divisions grown out of a need to sense (acquire data) these areas
Spectral Response Curve

![Graph showing spectral response curves for different types of land and water features.](image)
Panchromatic Imaging

• An image collected in a broad wavelength range

• Generally rendered in black and white

• ETM+ sensor 15-meter images are collected over the visible portion of the electromagnetic spectrum
Panchromatic Imaging

Single Wavelength Range

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Panchromatic Imaging

Single Wavelength Range

![Graph showing percent reflectance vs wavelength for different terrains. The graph includes curves for Pinewoods, Grasslands, Red Sand Pit, and Silty Water. The x-axis represents wavelength (μm) from 0.4 to 1.2, and the y-axis represents percent reflectance from 0 to 60. The curves peak at different wavelengths, indicating variations in reflectance across different terrains.]
Panchromatic Imaging
Multispectral Imaging

- Images acquired in more than one spectral or wavelength interval
- Multispectral images are non-contiguous in their coverage of the spectrum
- The TM sensor scans and stores seven individual images in spectral bands ranging from the blue wavelengths up to those in the thermal infrared
Multispectral Imaging

Landsat 7

Visible - Near IR  Short Wave IR  Thermal IR

Wavelength (um)
Multispectral Imaging
Hyperspectral Imaging

- Images have dozens to hundreds of narrow contiguous bands

- Vast quantities of data because of the number of bands simultaneously imaged, creating a 3-dimensional image cube

- Hyperion images the earth's surface in 220 contiguous spectral bands, covering the region from 400 nm to 2.5 µm, at a ground resolution of 30 m
Hyperspectral Imaging

Deciduous trees (Maple)

Coniferous trees (Pine)
Hyperspectral Imaging

Hyperspectral sensors measure the spectrum of the light reflected at each pixel.

Components of Spectrum:
- Green Vegetation
- Dry Vegetation
- Soil
- Kaolinite

(NEMO Project Office, United States Navy)
Hyperspectral Image Analysis

• Anomaly Detection

• Target Detection

• Material Identification
Anomaly Detection

- Commonly used when nothing is known about the scene under surveillance, but we wish to identify anything that might be out of place
- Identify pixels that are uniquely different from the dominate spectra (background)
- Pixels that fail to conform to the background are flagged as anomalies
Target Detection

• Find within the imagery, materials that are present and match them to existing spectral libraries

• All pixels whose spectra match the target spectrum (to a specified level of confidence) are marked as potential targets

• The underlying assumption is that the pixels containing the target are "pure"
Material Identification

• Determine sub-pixel concentrations of materials by comparing unknown spectra against spectral libraries

• Sub-pixel materials are known as endmembers

• A spectral endmember is the spectral signature for a pure surface
Contact Information

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