INF250

Spectral imaging

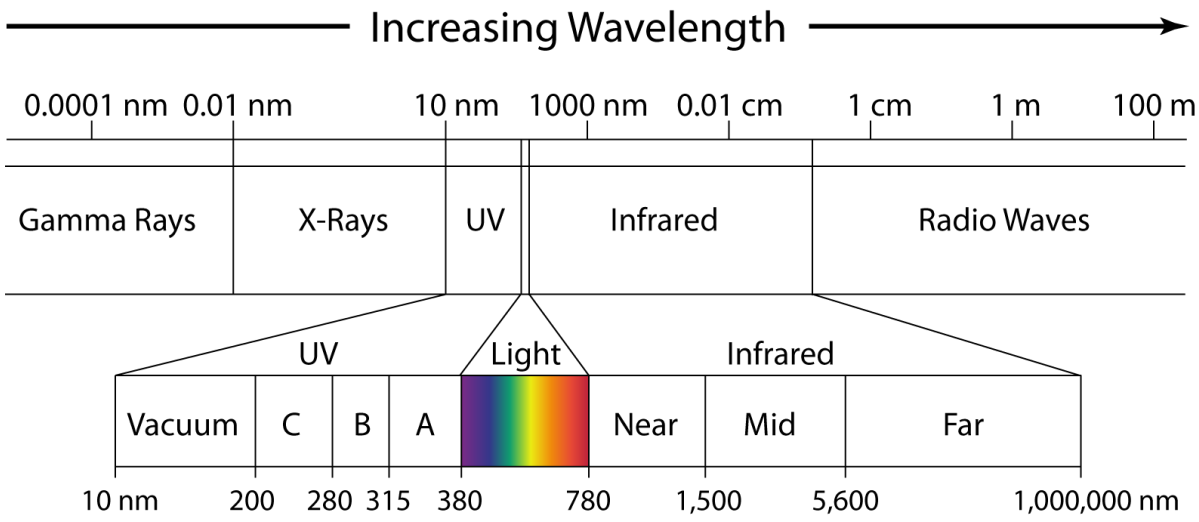
Learning goals

- What is multispectral and hyperspectral imaging ?
- What kind of cameras are used for hyperspectral imaging
- Give som examples of research one can do with hyperspectral imaging

Next lecture:

- Describe how PCA works on a hyperspectral image
- Describe how k-means clustering works
- Describe supervised classification

Spectral imaging



Conventional imaging

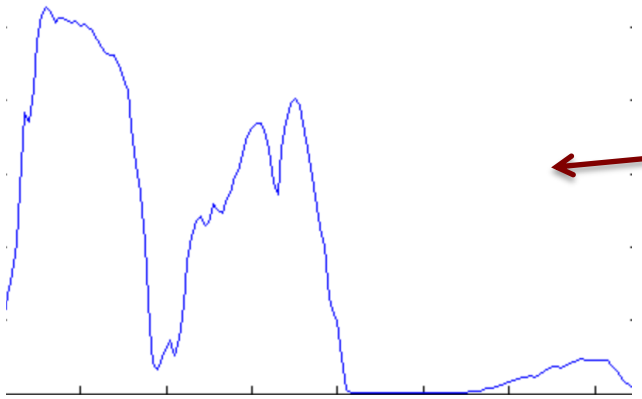
Red ≈ **645** nm

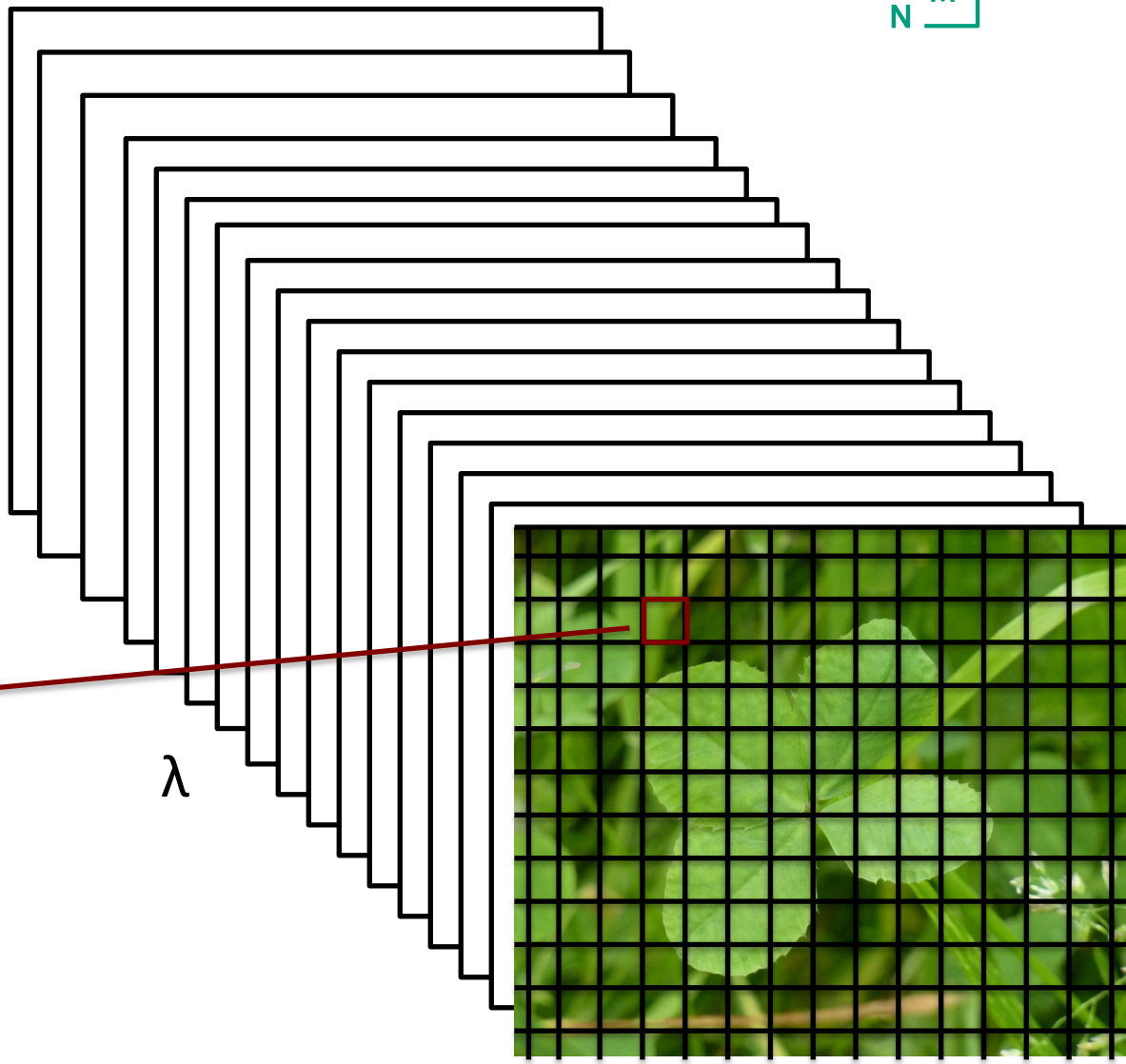
Green ≈ **510** nm

Blue ≈ **400** nm

Multispectral imaging

Hyperspectral imaging

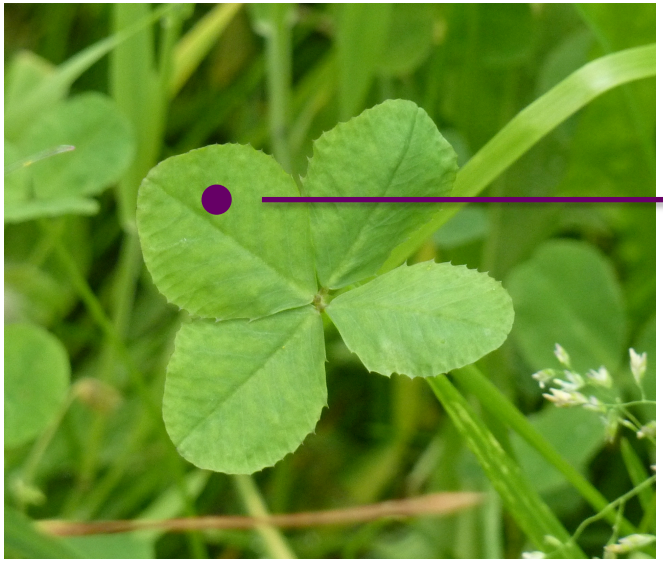


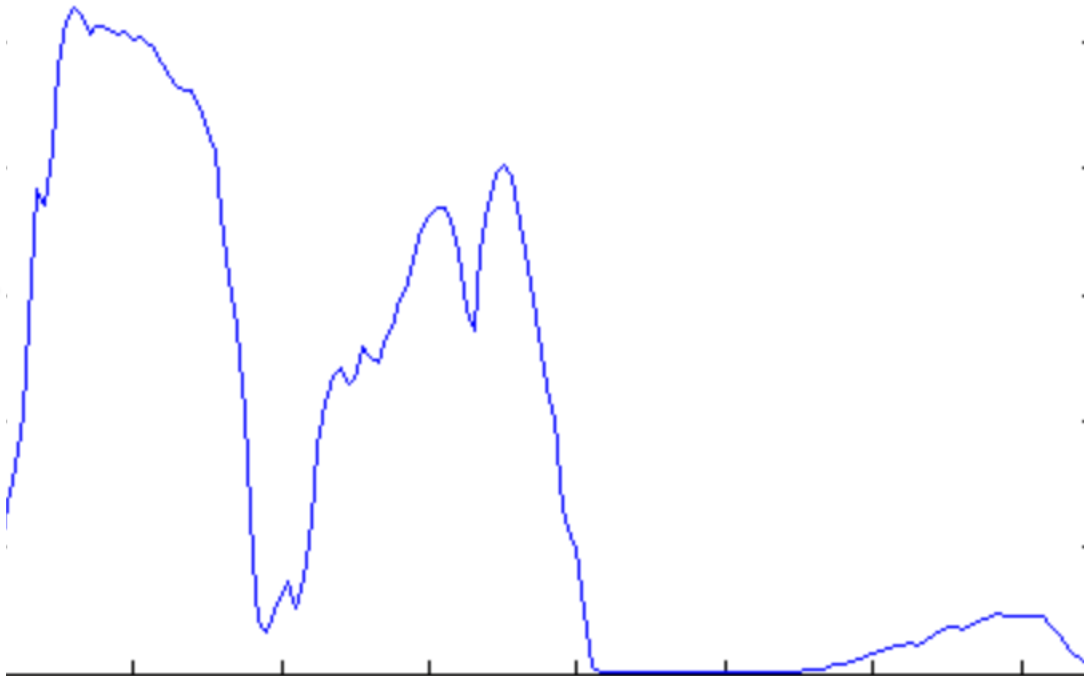


Pixel

spectrum

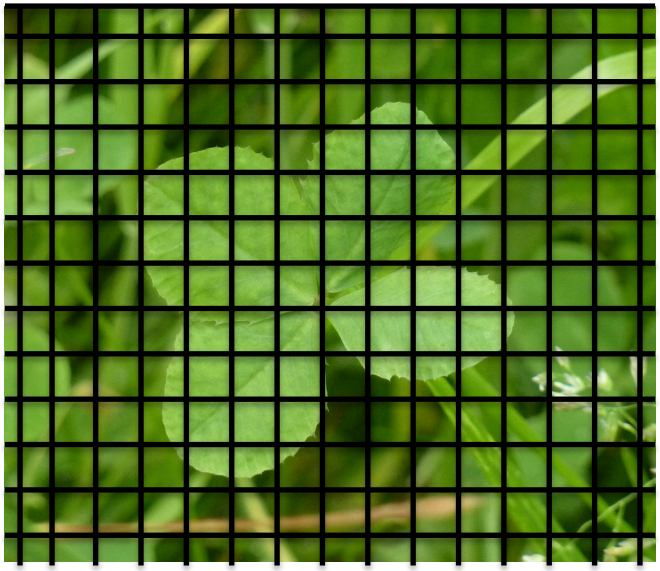
Conventional spectroscopy

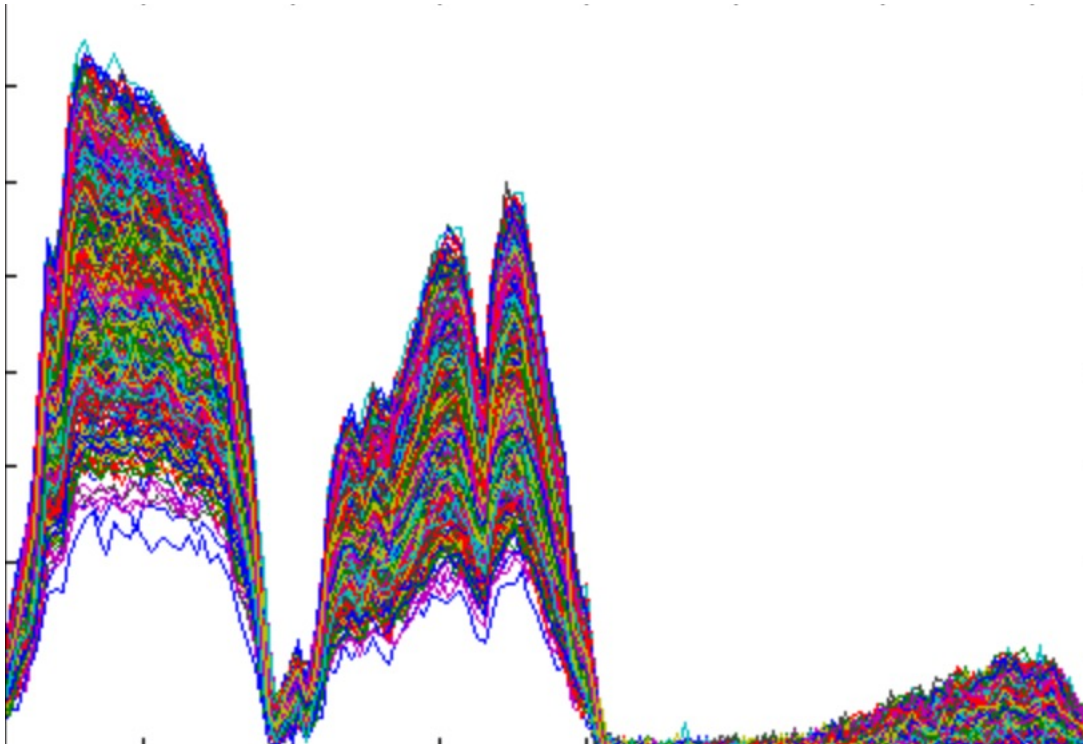




λ

Hyperspectral

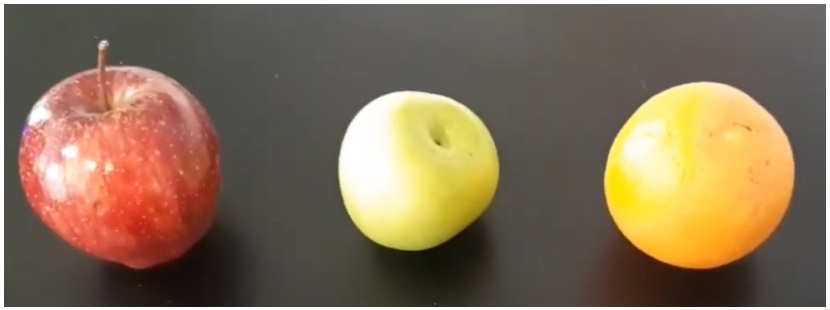




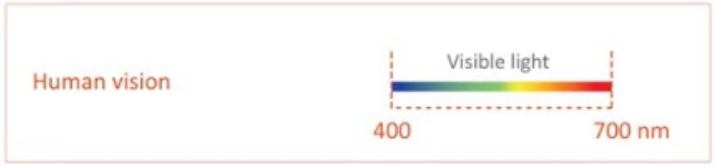
λ

http://www.markelowitz.com/Hyperspectral.html
http://www.microimages.com/documentation/Tutorials/hyprspec.pdf
https://www.youtube.com/watch?v=EaeRIzm-tWM

Image Analysis – Why hyperspectral?



- Colour is important for classification tasks
- BUT: even though we only see in RGB we aren´t just limited to these three colours



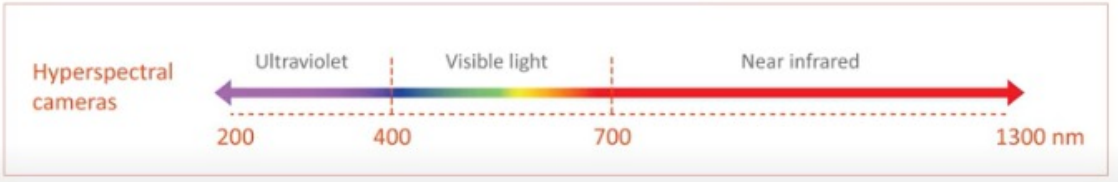
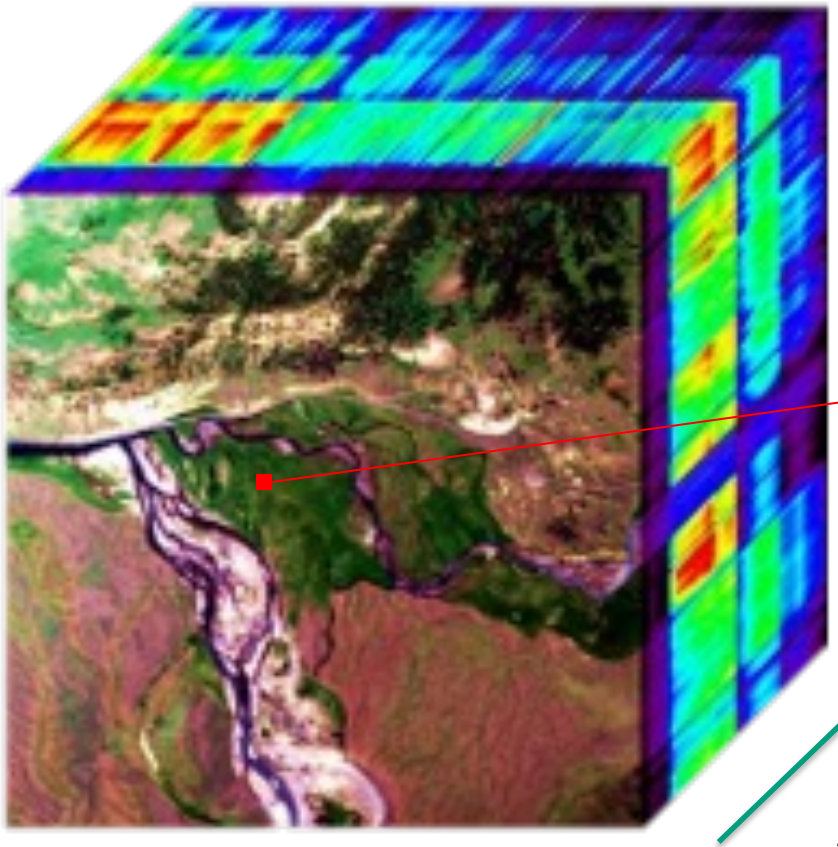


Image Analysis – 3D hyperspectral data cube



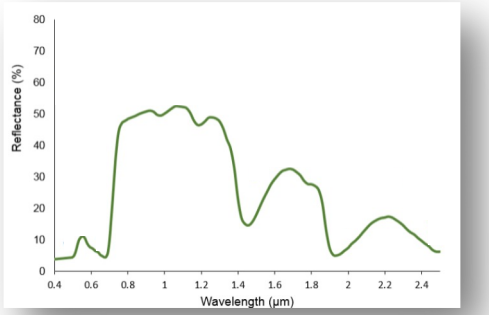
X and Y – spatial

λ – spectral

RGB

Hyperspectral

R:0
G:130
B:65



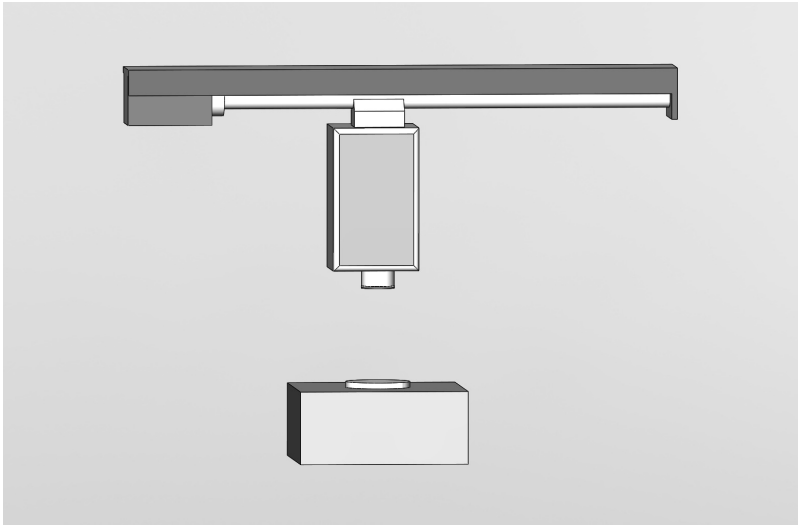
y

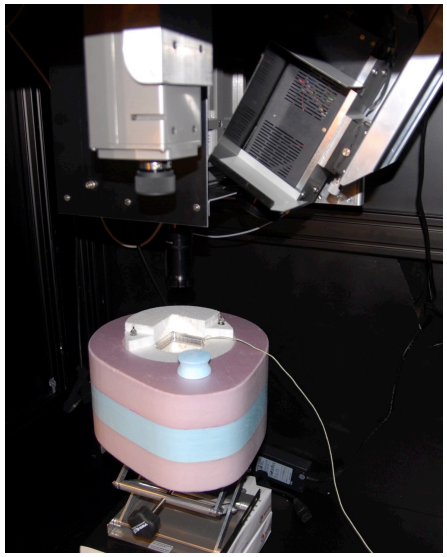
x

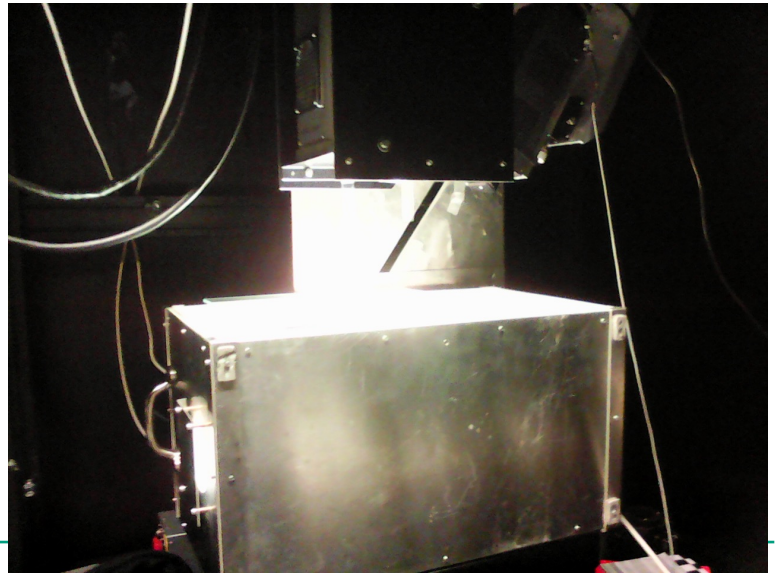
λ

Hyperspectral cameras at Realtek

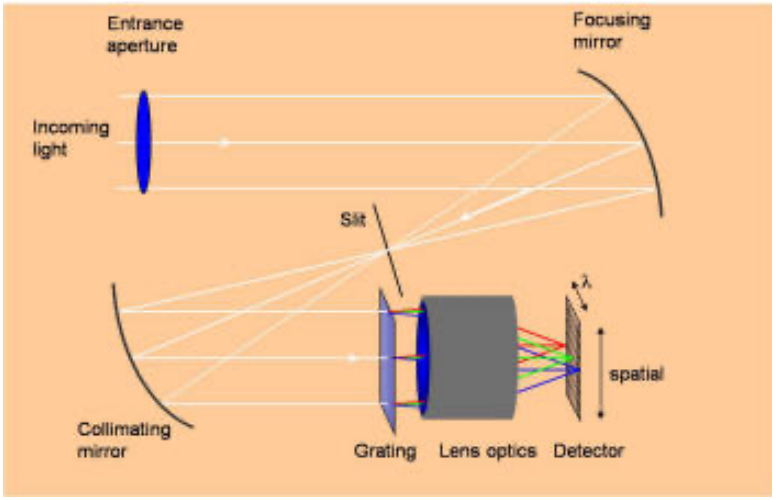
VIS/NIR 400-1000 nm (Specim)
SWIR 1000-2500 nm (Specim)
SWIR 1000-2500 nm (NEO)

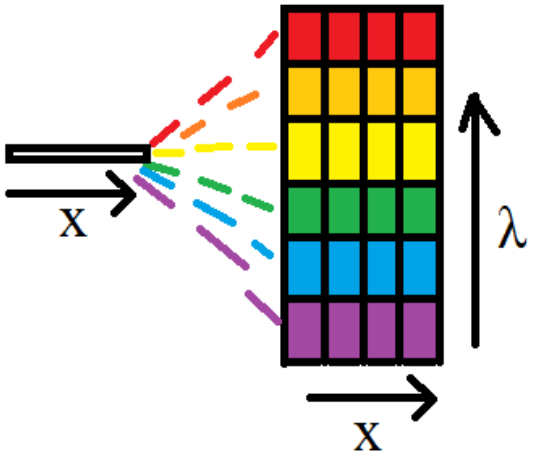






Hyperspectral imaging principle

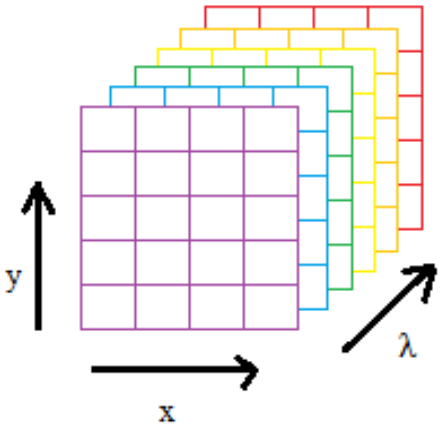




wavelength

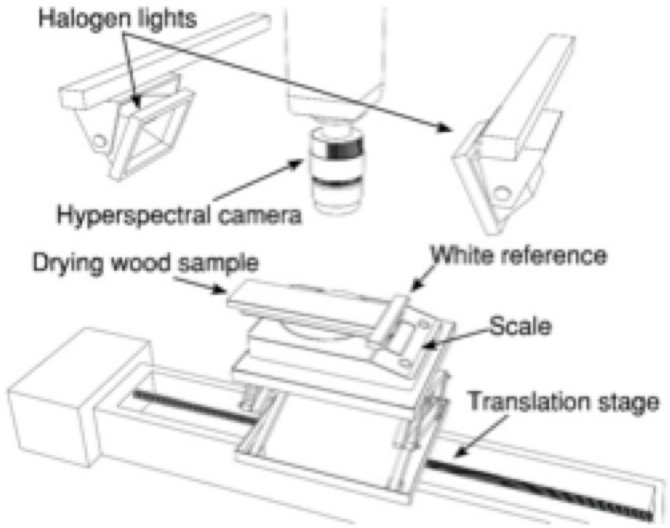
Two types of cameras:

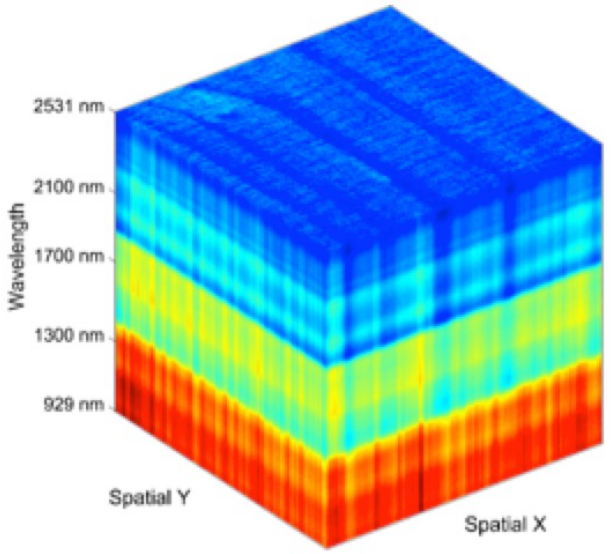
- Line scan camera (bush broom)
- Filter wheel camera



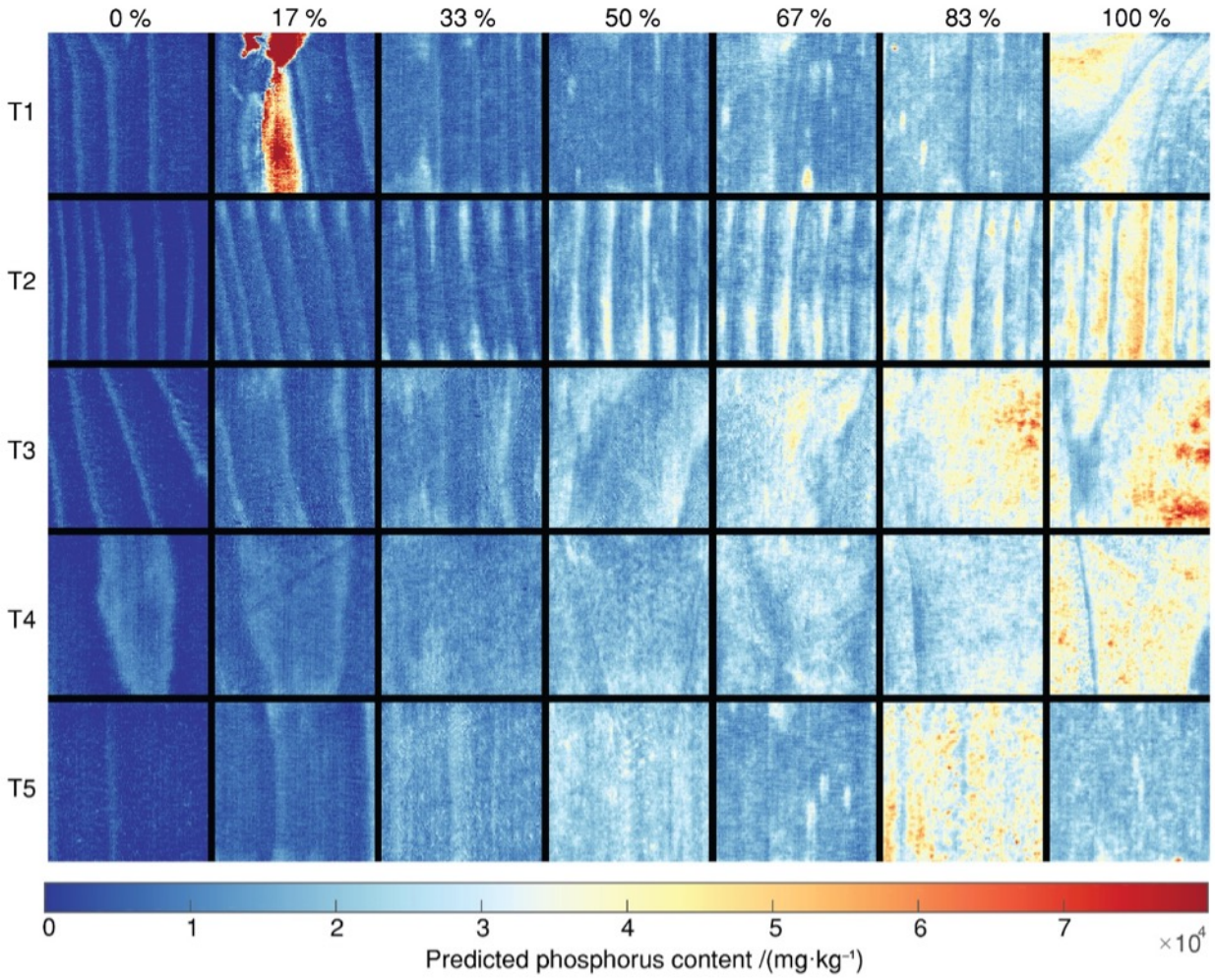
wavelength

Laboratory measurements

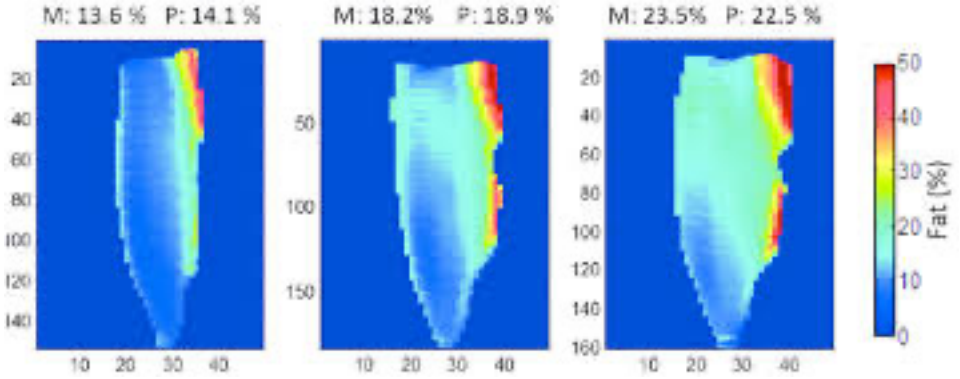




Predicted phosphorus content in wooden surfaces



Applications of hyperspectral imaging

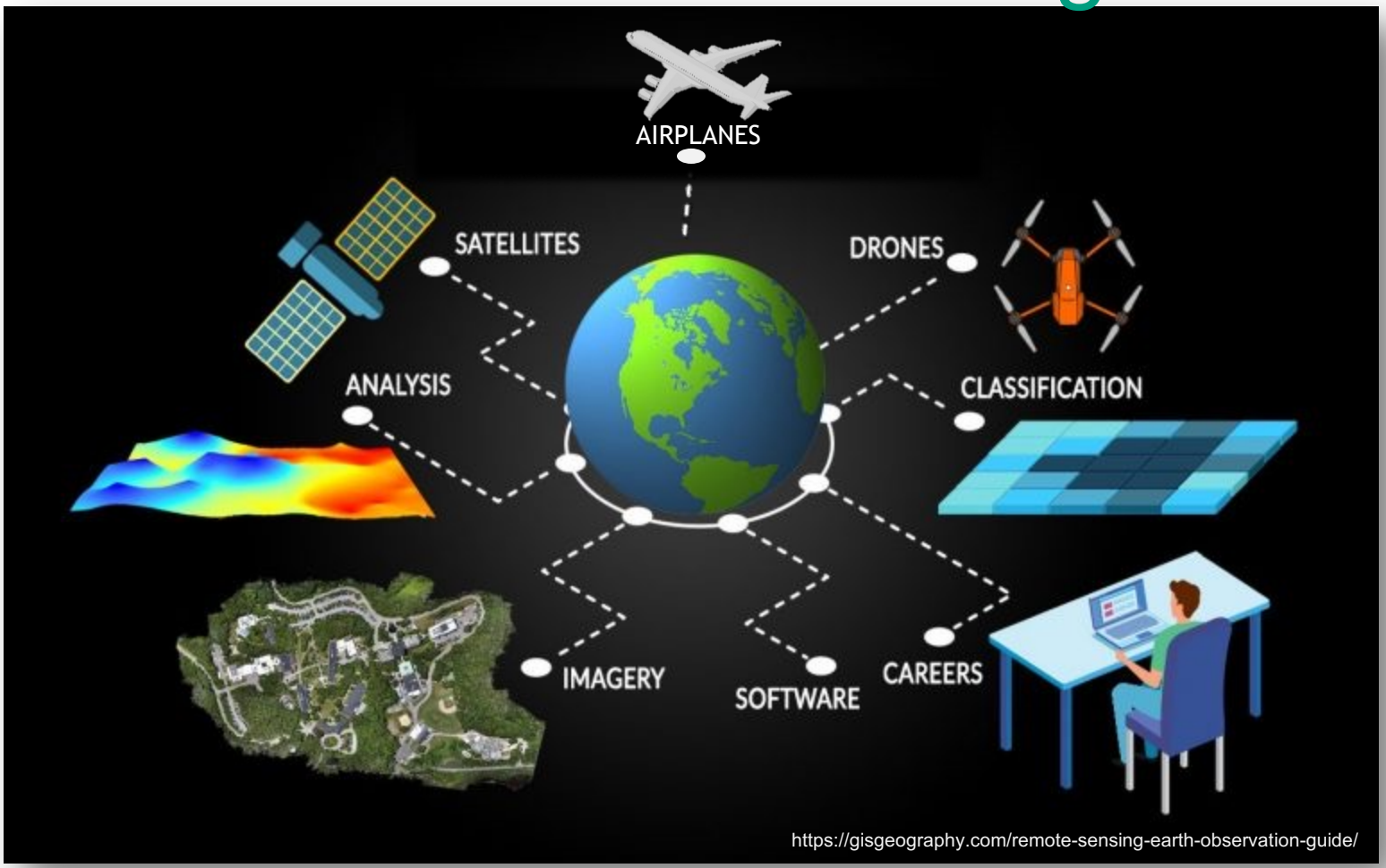


Fat content in salmon, Wold et al. Nofima

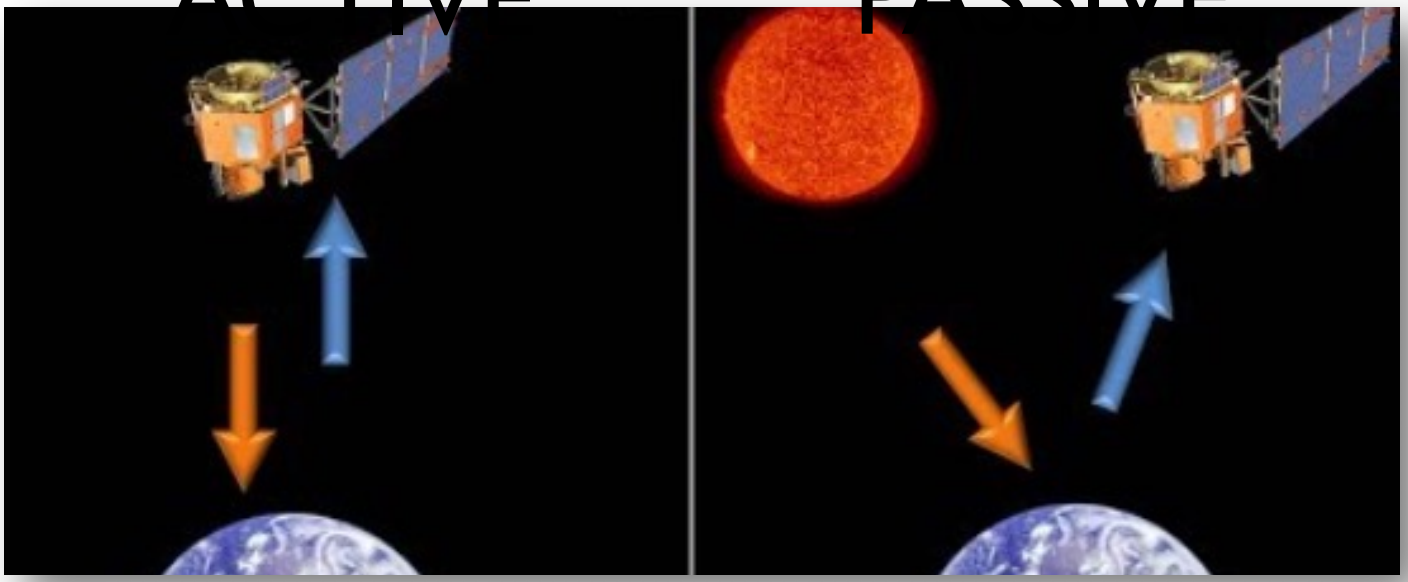
Fruit sorting

https://www.youtube.com/watch?v=Lz88nsWL4kw

Power of Remote Sensing



Active vs. Passive Remote Sensing

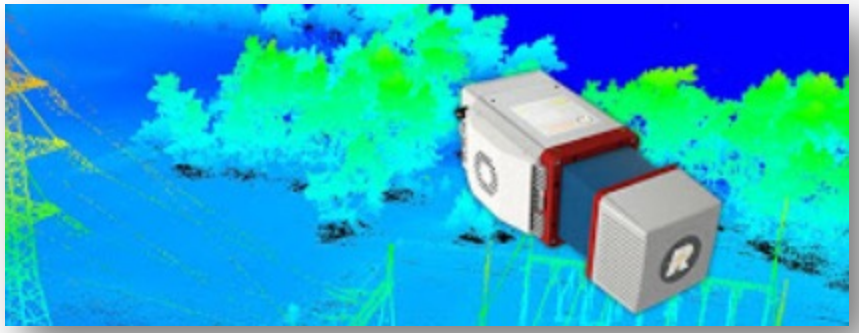


Active

Passive

- LiDAR (Light Detection and Ranging)

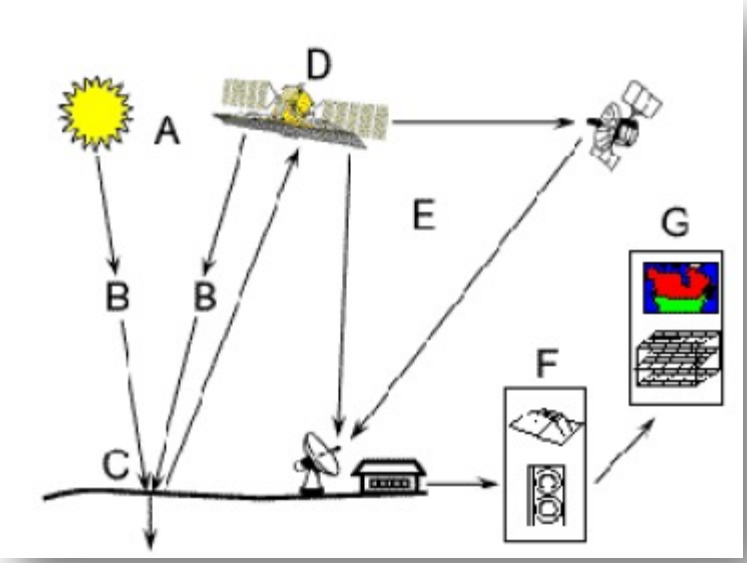
- Multi-/ hyperspectral sens

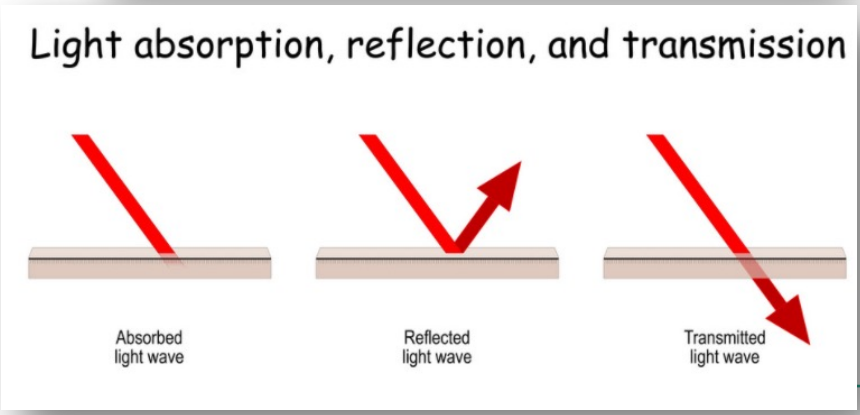


Is a camera an active or passive sensor?

Hint:

Passive remote sensing

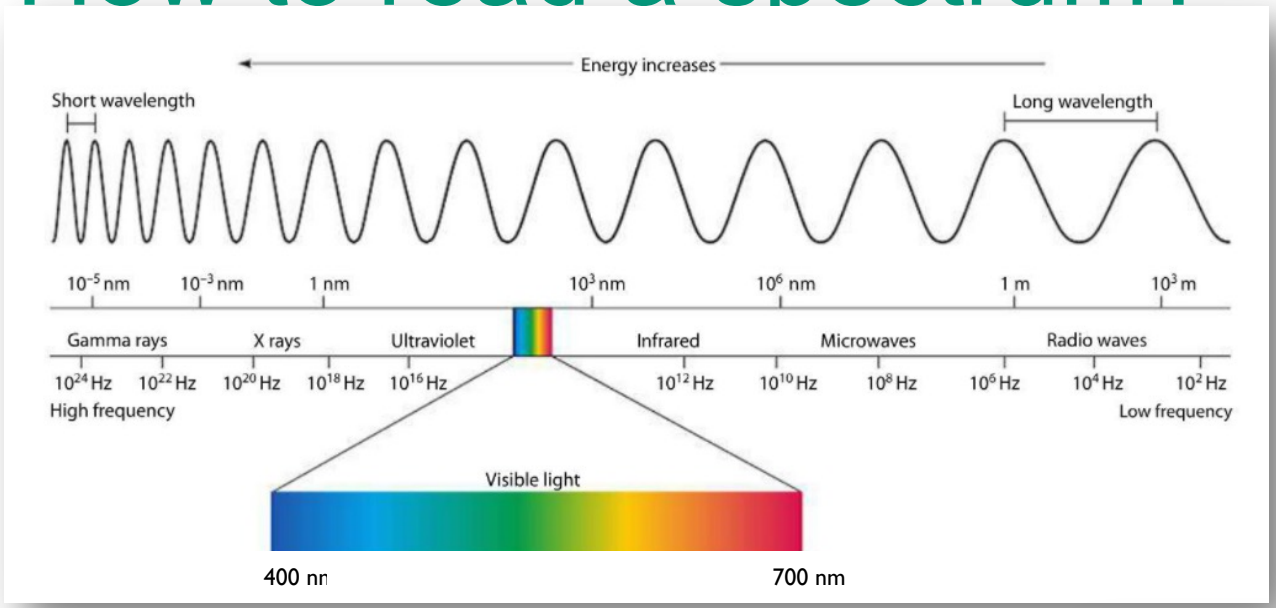




A Energy source/Illumination

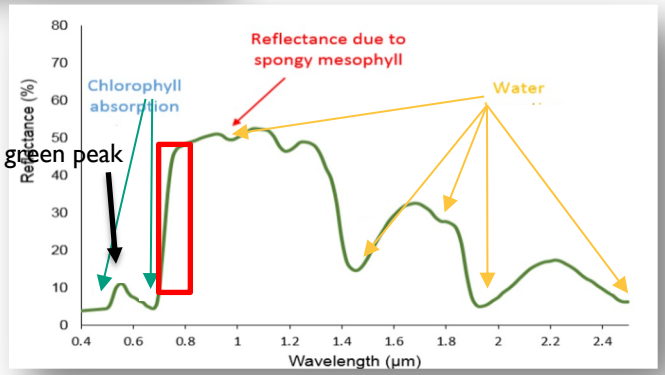
B Interaction with the Atmosphere

How to read a spectrum?

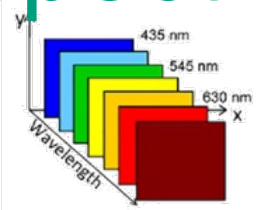


Red edge:

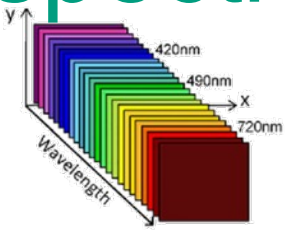
scattering due to leaf internal structure in the NIR region



Multispectral vs. Hyperspectral

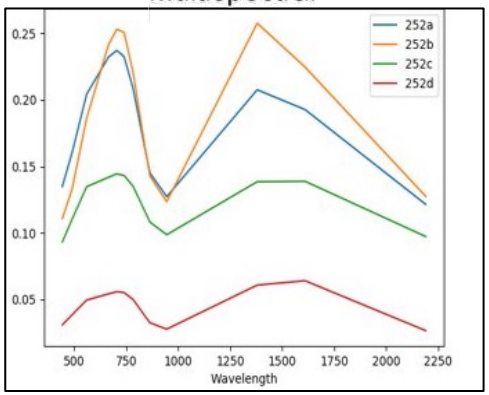


Mehta, 2018

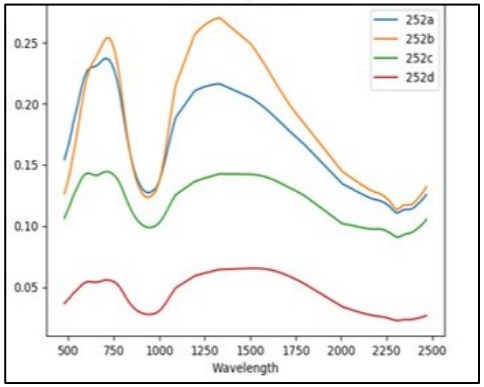


Mehta, 2018

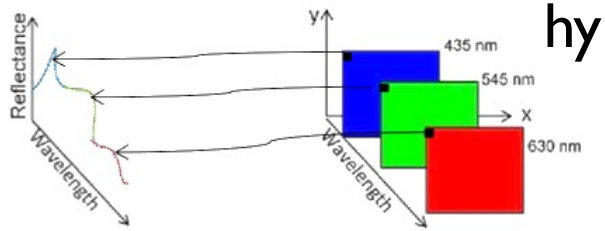
Multispectral



Hyperspectral



multi – more than one

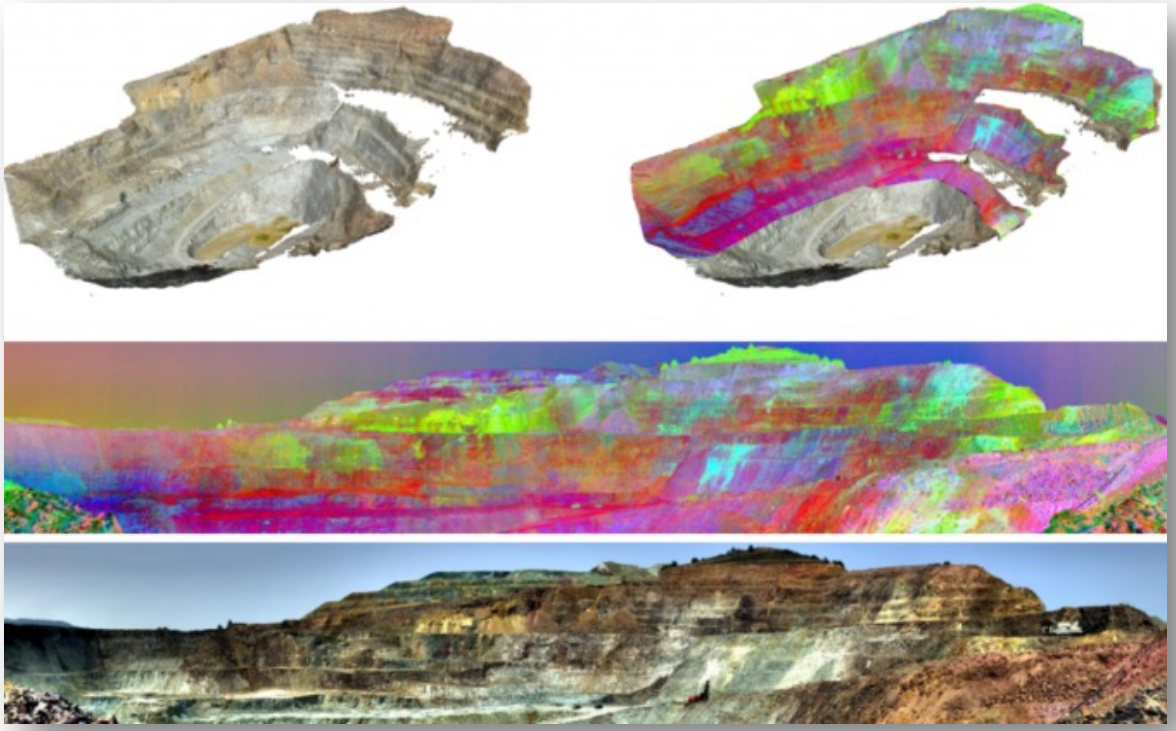


Mehta, 2018

Spectroscopy RGB

hyper – over, excessively

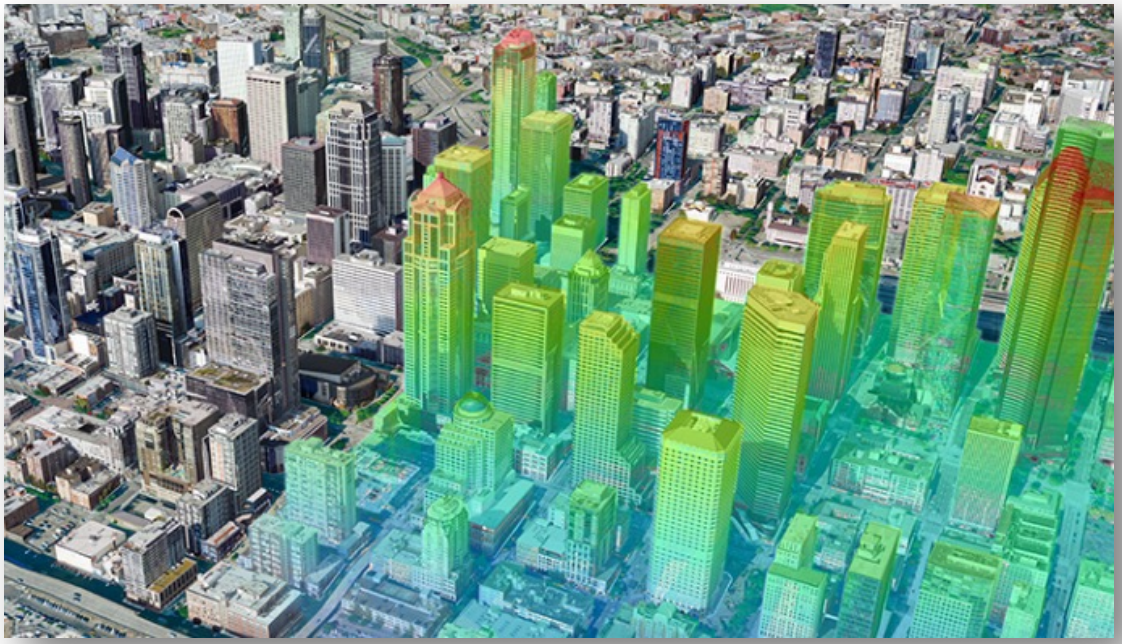
Cool applications – Mine industry



Skouriotissa, Cyprus

- Mineral exploration
  - 3D modelling
- Flying drones ☺

3D City Modeling



- Urban planning
- Navigation systems
- 3D models
- Urbanization level

Saving lives

- Searching for aircrafts and saving lives after fatal crashes

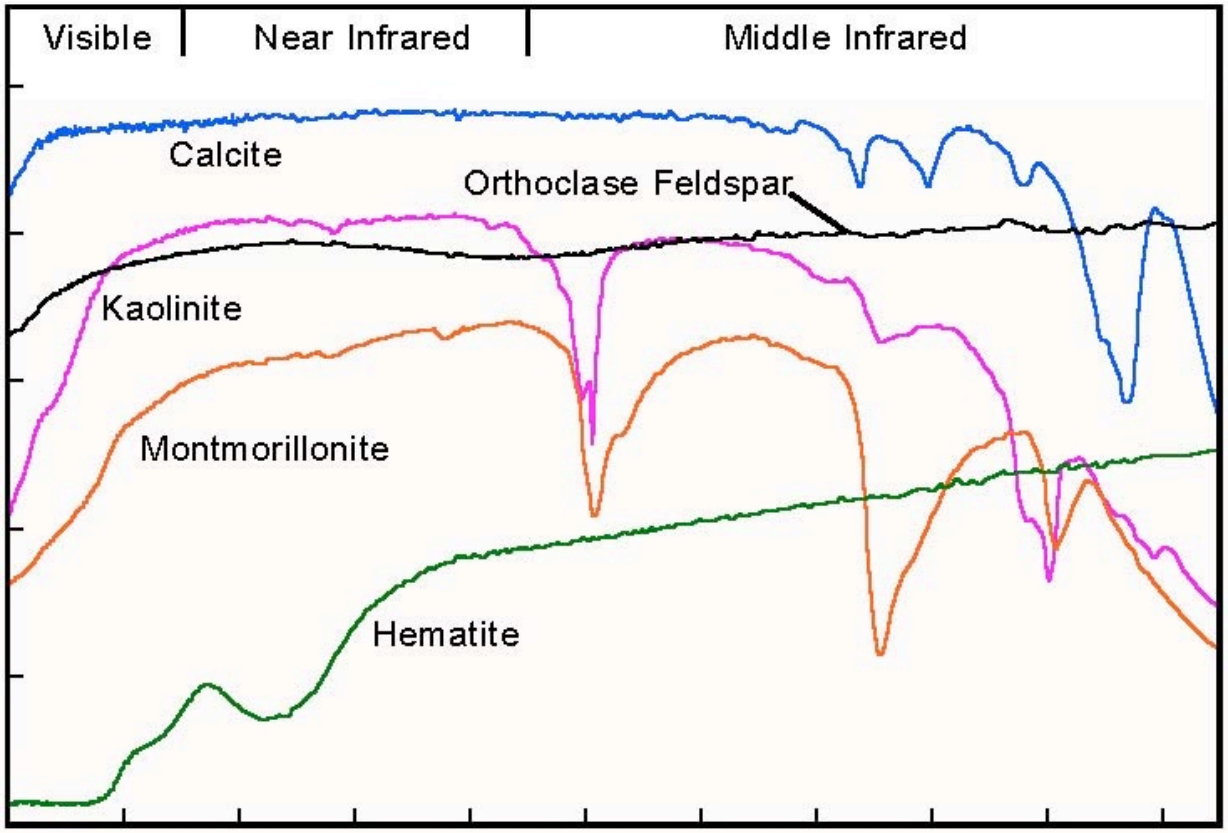
Forecasting weather

- Forecasting weather to warn about natural disasters

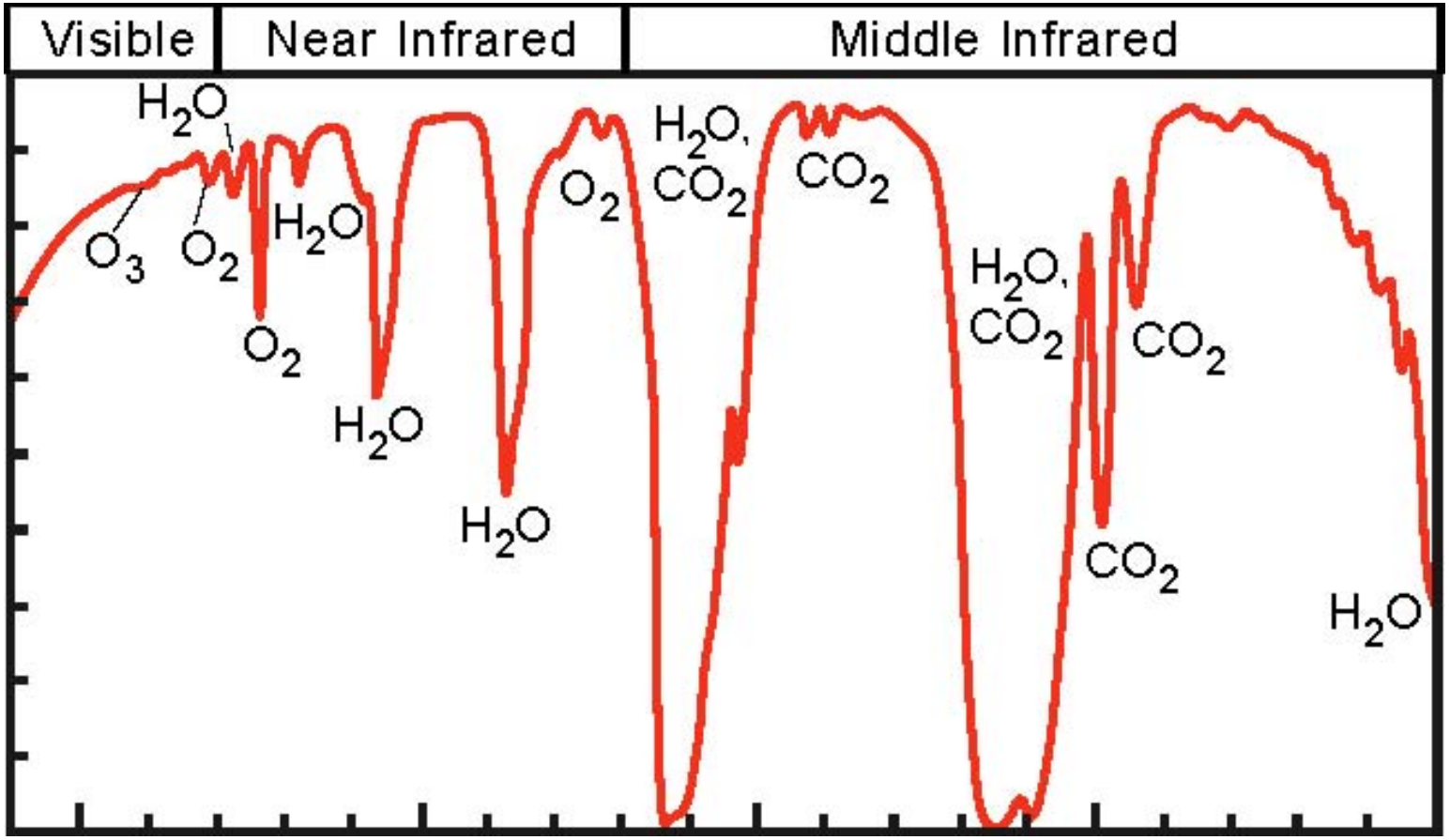
Volcanoes

- Monitoring active volcanoes using thermal remote sensing

mineralogy

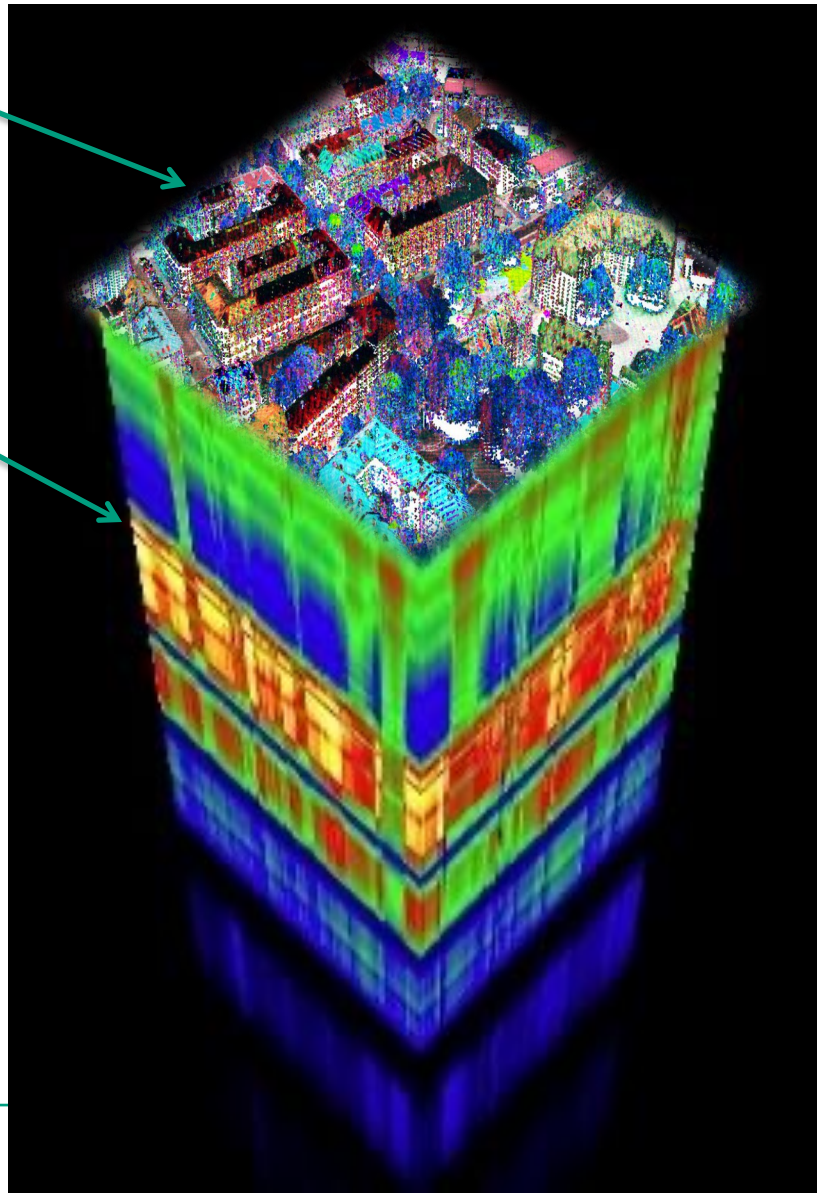

Visible
Near Infrared
Middle Infrared
Calcite
Orthoclase Feldspar
Kaolinite
Montmorillonite
Hematite

Atmospheric absorption bands

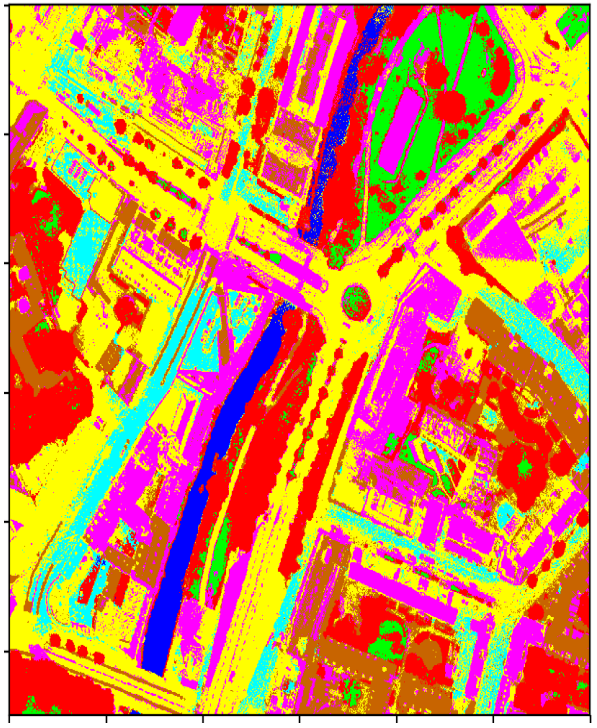


Laser data (LiDAR) yields a 3D model of the surface in the form of a point cloud

Hyperspectral data gives a detailed spectrum of channels in the visible and the near infrared and shortwave infrared, bringing out «invisible» differences in the surface material



Collaboration with Terratec and the municipality of Oslo



- Asphalt
- Grass
- Trees
- Dark rooftops + sand
- Red rooftops
- Shadowed areas (asphalt)