

UE Parcours Électif

Projet: Télédétection satellitaire

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Grenoble Images sPeech Signals and Automatics Lab (GIPSA-Lab)

Département Images et Signal
Grenoble Institute of Technology



Outline

1 Introduction

2 Remote sensing systems

- Optical remote sensing
- LiDAR

3 Remote sensing applications

4 Project

1 Introduction

2 Remote sensing systems

- Optical remote sensing
- LiDAR

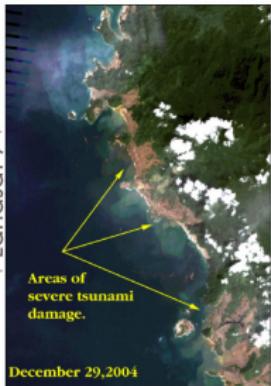
3 Remote sensing applications

4 Project



- On December 26, 2004, a devastating tsunami hit many coastal regions on the Indian Ocean.
 - One of the most devastating natural disasters in recorded history
 - 14 countries hit (Indonesia, Sri Lanka, India, Thailand...)
 - Over 230.000 people killed
-
- How to assess the damage?
 - Which are the most hit points?
 - How to plan the humanitarian aid missions?

Tsunami 2004



t

Landsat 7

- 183 km swath width
- 30 m spatial res
- 15 m pan-band res



January 2, 2005

QuickBird

- 16.5 km swath width
- 2.44 m res.
- 61 cm pan-band res

- **Remote:** operating without a direct contact
- Sensing: perform a measure
- Measure something at a distance, rather than in situ. It relies on propagated signals of some sort, for example optical, acoustical, or microwave.
- Remote sensing data can consist of discrete, point measurements or a profile along a flight path, or measurements over a two-dimensional spatial grid, i.e., images.

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② Remote sensing systems

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④ Project

Syllabus

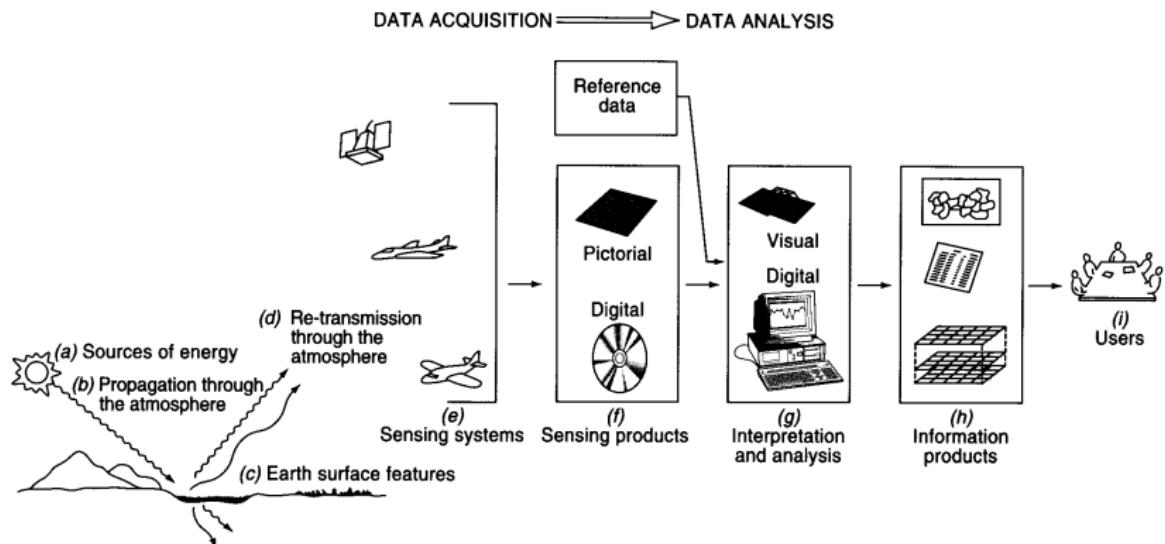


Figure 1.1 Electromagnetic remote sensing of earth resources.

Remote sensing systems

		Passive systems		Active systems	
Reflected sunlight		Thermal emission			
		Infrared	Microwave (radio)	Visible/IR	Microwave (radio)
Non-imaging		Thermal infrared radiometry (6)	Passive microwave radiometry (7)	Laser profiling (8)	Radar altimetry (8) Microwave scatterometry (9)
Imaging	Aerial photography (5)	Thermal infrared imaging (6)	Passive microwave radiometry (7)		Real aperture radar (9) Synthetic aperture radar (9)
	Visible/near-infrared imaging (6)				
Sounding	Ultraviolet backscatter sounding (6)	Thermal infrared sounding (6)	Passive microwave sounding (7)	Lidar (9)	

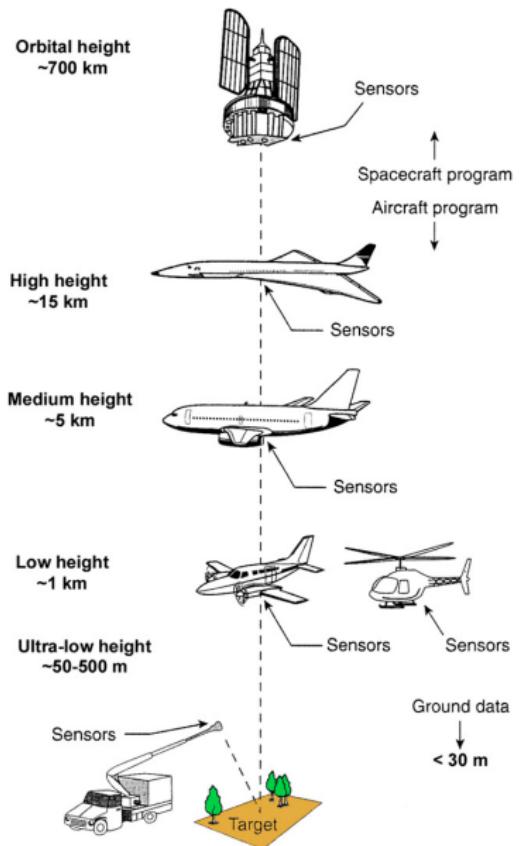
Passive remote sensing

name	wavelength range	radiation source	surface property of interest
Visible (V)	0.4–0.7 μm	solar	reflectance
Near InfraRed (NIR)	0.7–1.1 μm	solar	reflectance
Short Wave InfraRed (SWIR)	1.1–1.35 μm 1.4–1.8 μm 2–2.5 μm	solar	reflectance
MidWave InfraRed (MWIR)	3–4 μm 4.5–5 μm	solar, thermal	reflectance, temperature
Thermal or LongWave InfraRed (TIR or LWIR)	8–9.5 μm 10–14 μm	thermal	temperature
microwave, radar	1 mm–1 m	thermal (passive), artificial (active)	temperature (passive), roughness (active)

Active remote sensing

band	frequency (GHz)	wavelength (cm)	examples (frequency in GHz)
Ka	26.5–40	0.8–1.1	SSM/I (37.0)
K	18–26.5	1.1–1.7	SSM/I (19.35, 22.235)
Ku	12.5–18	1.7–2.4	Cassini (13.8)
X	8–12.5	2.4–3.8	X-SAR (9.6)
C	4–8	3.8–7.5	SIR-C (5.3), ERS-1 (5.25), RADARSAT (5.3)
S	2–4	7.5–15	Magellan (2.385)
L	1–2	15–30	Seasat (1.275), SIR-A (1.278), SIR-B (1.282), SIR-C (1.25), JERS-1 (1.275)
P	0.3–1	30–100	NASA/JPL DC-8 (0.44)

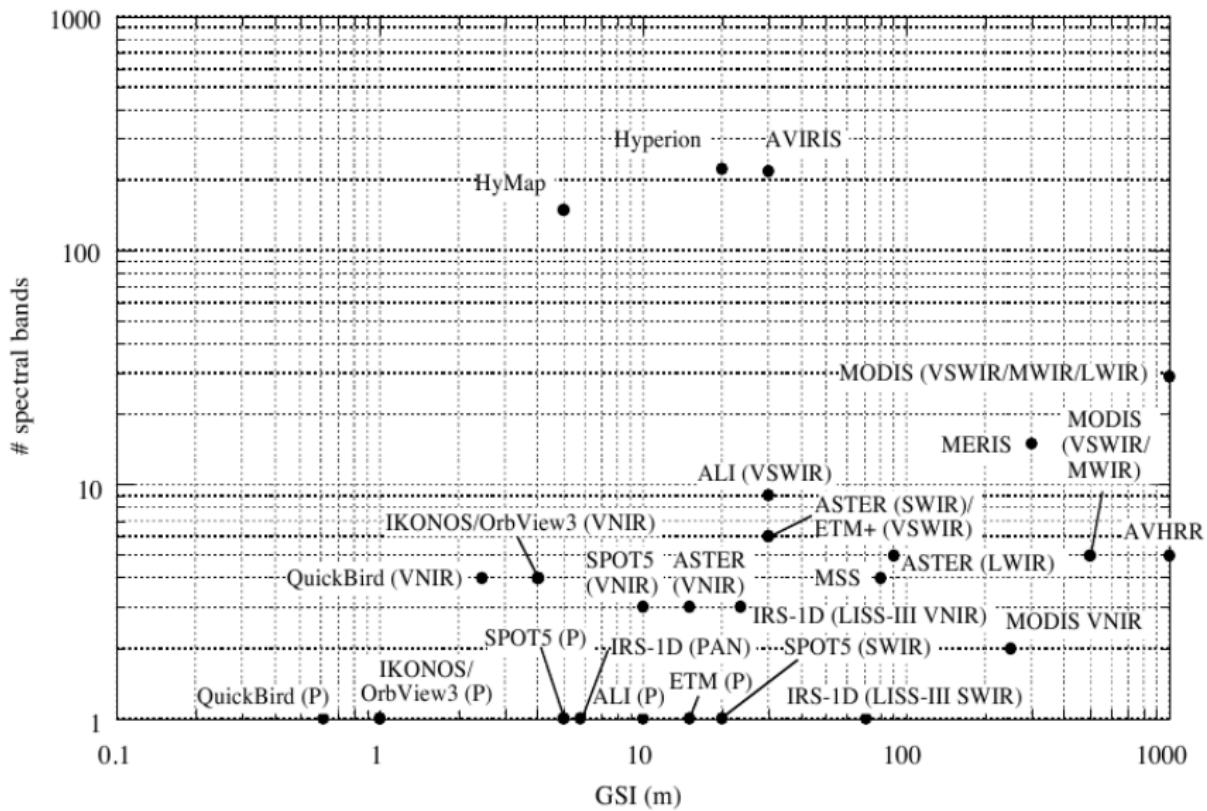
Remote sensing platforms



Syllabus

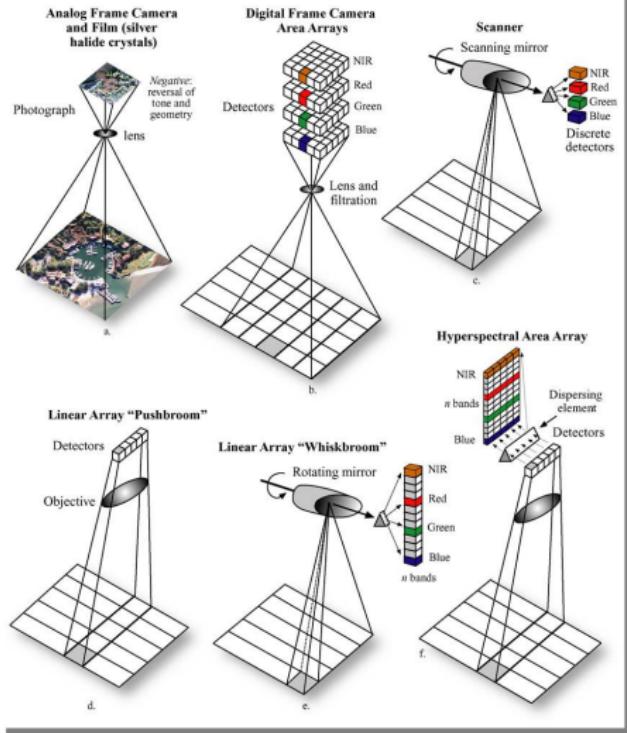


Source: NOAA Satellite and Information Service



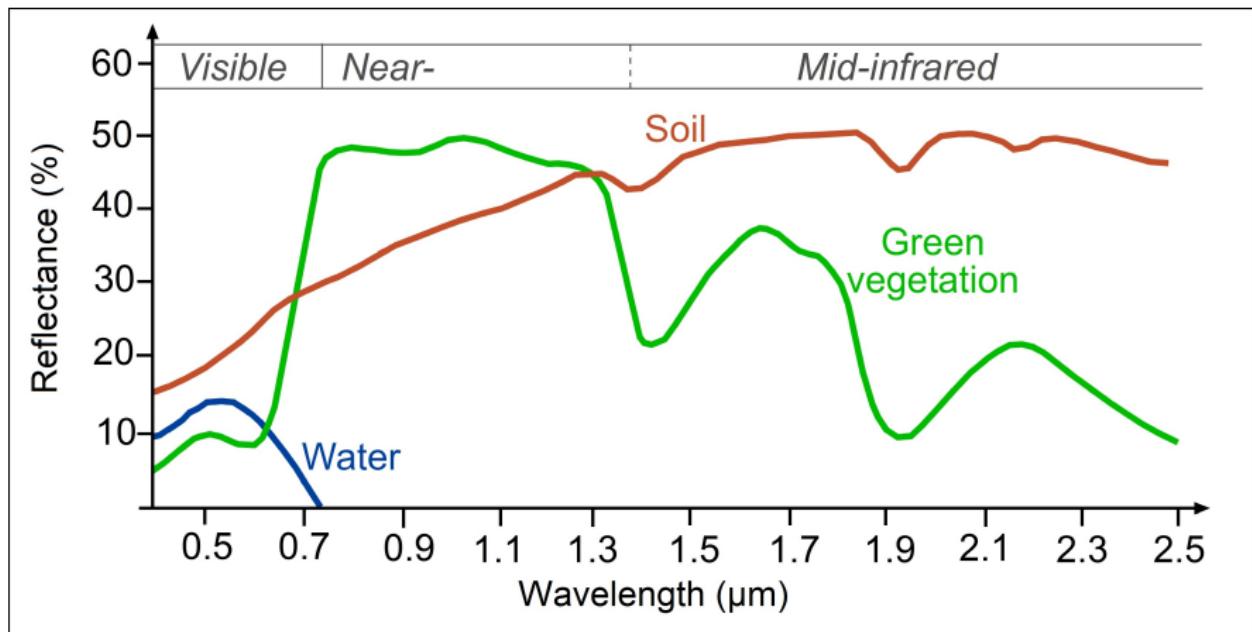
Optical systems

Remote Sensing Systems Used to Collect Aerial Photography, Multispectral and Hyperspectral Imagery

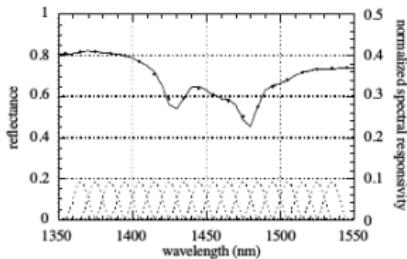


Source: Jensen

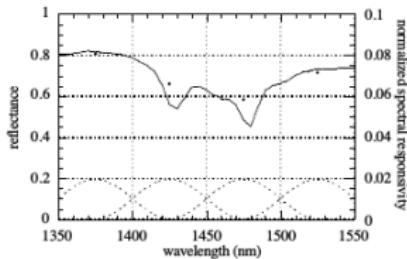
Spectral signature



Hyperspectral imaging

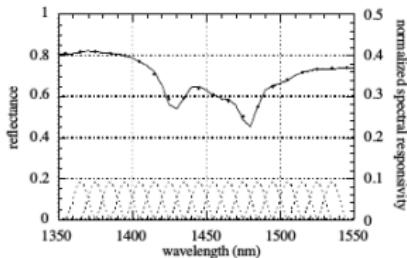


10nm spectral bandwidth

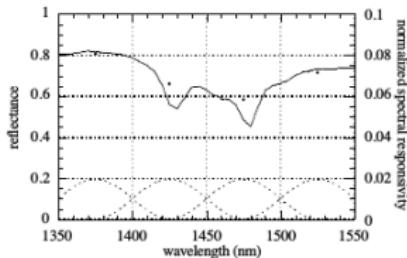


50nm spectral bandwidth

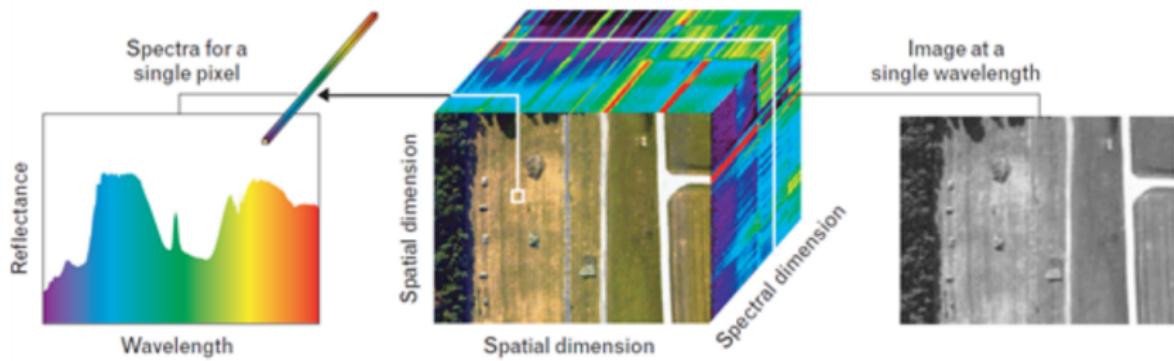
Hyperspectral imaging



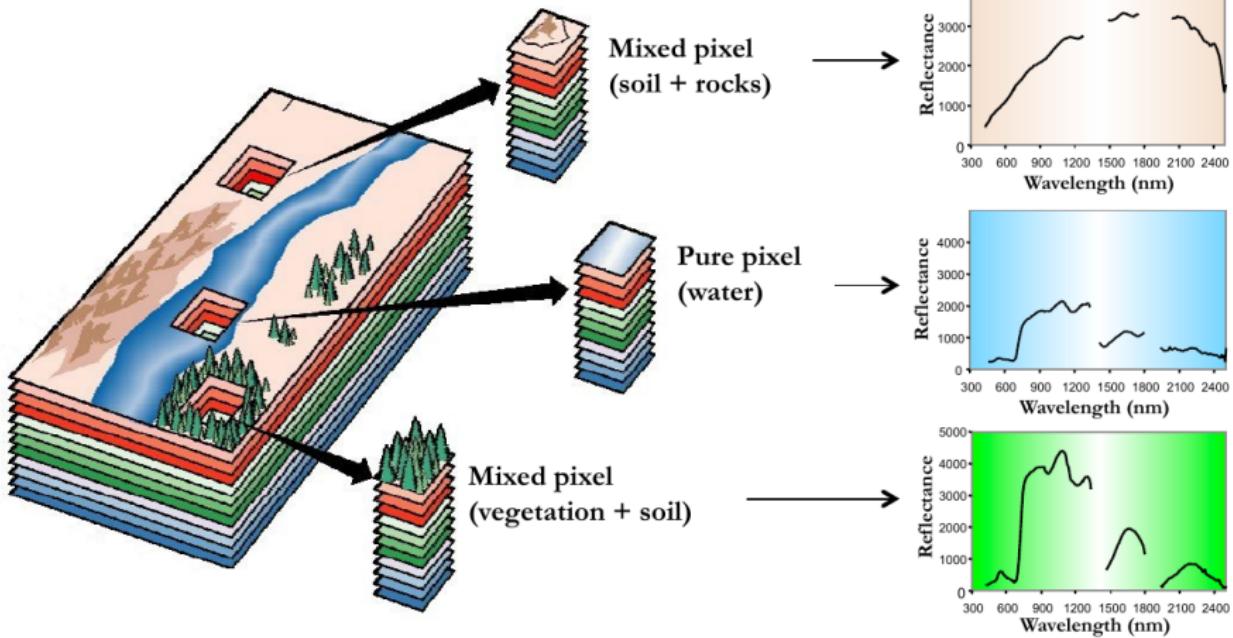
10nm spectral bandwidth



50nm spectral bandwidth



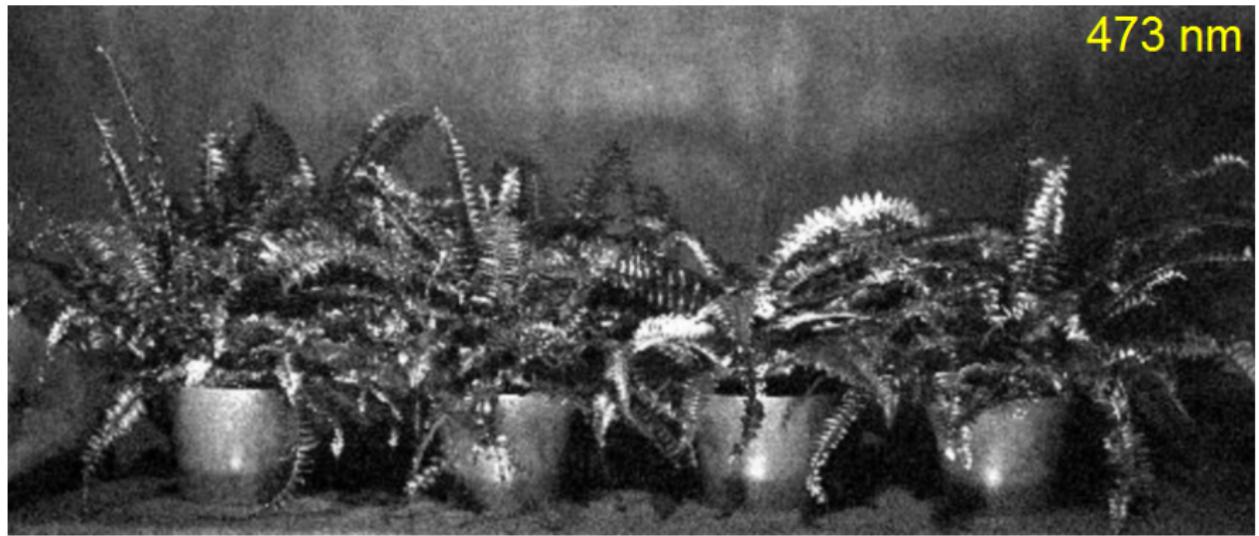
Hyperspectral imaging



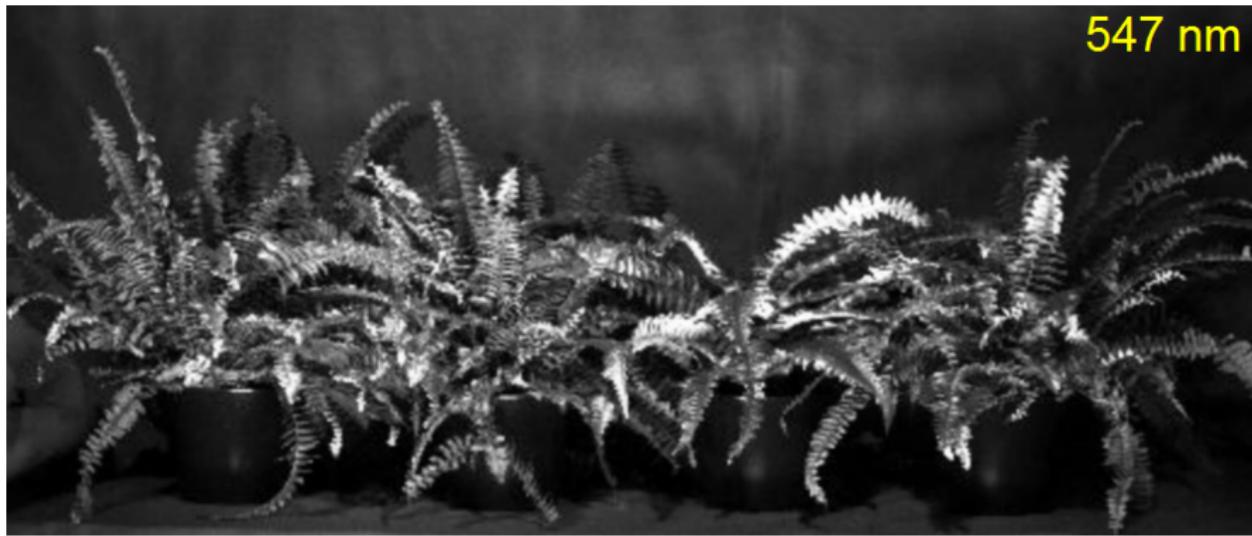
Example



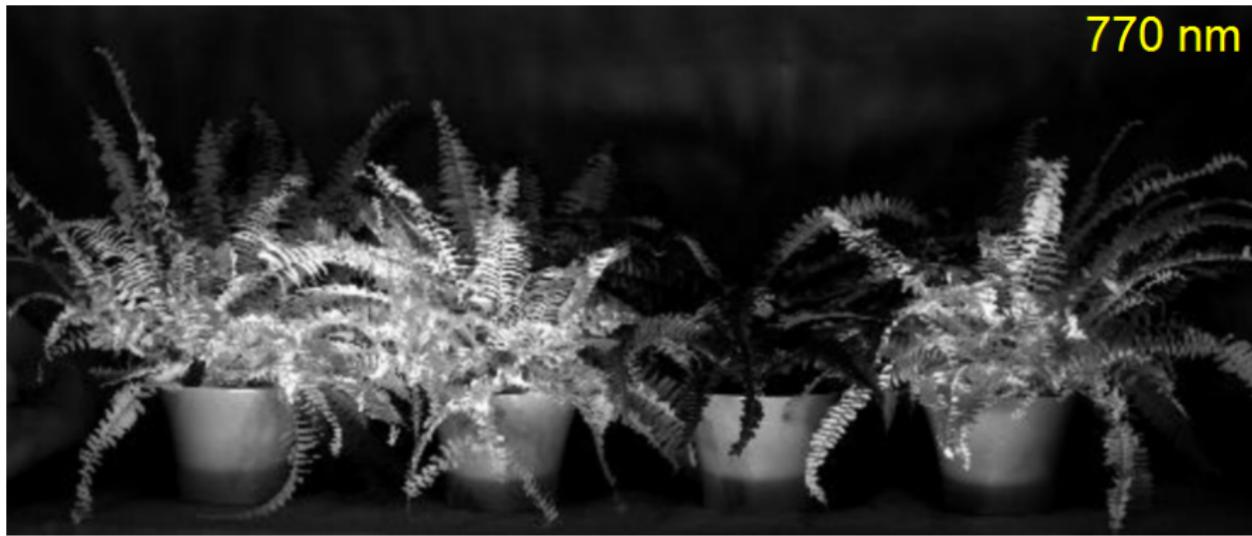
Example



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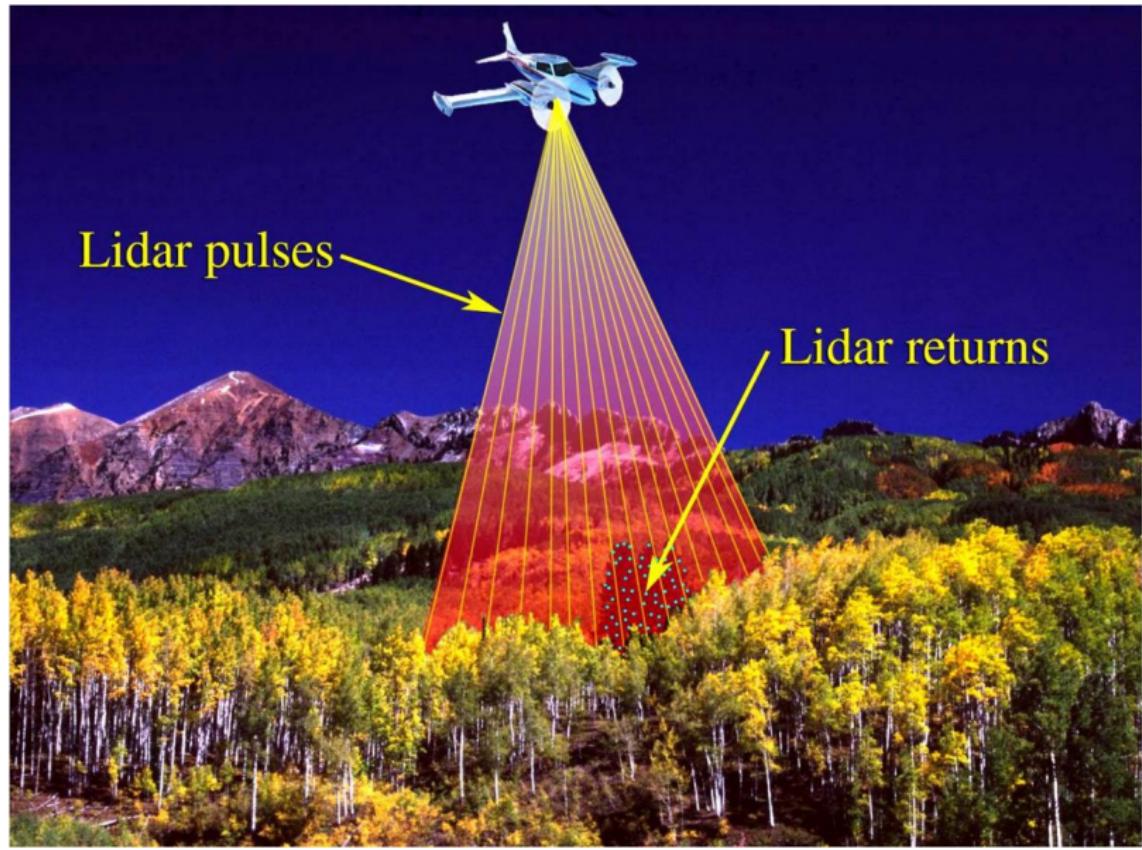


Light Detection and Ranging (LiDAR)

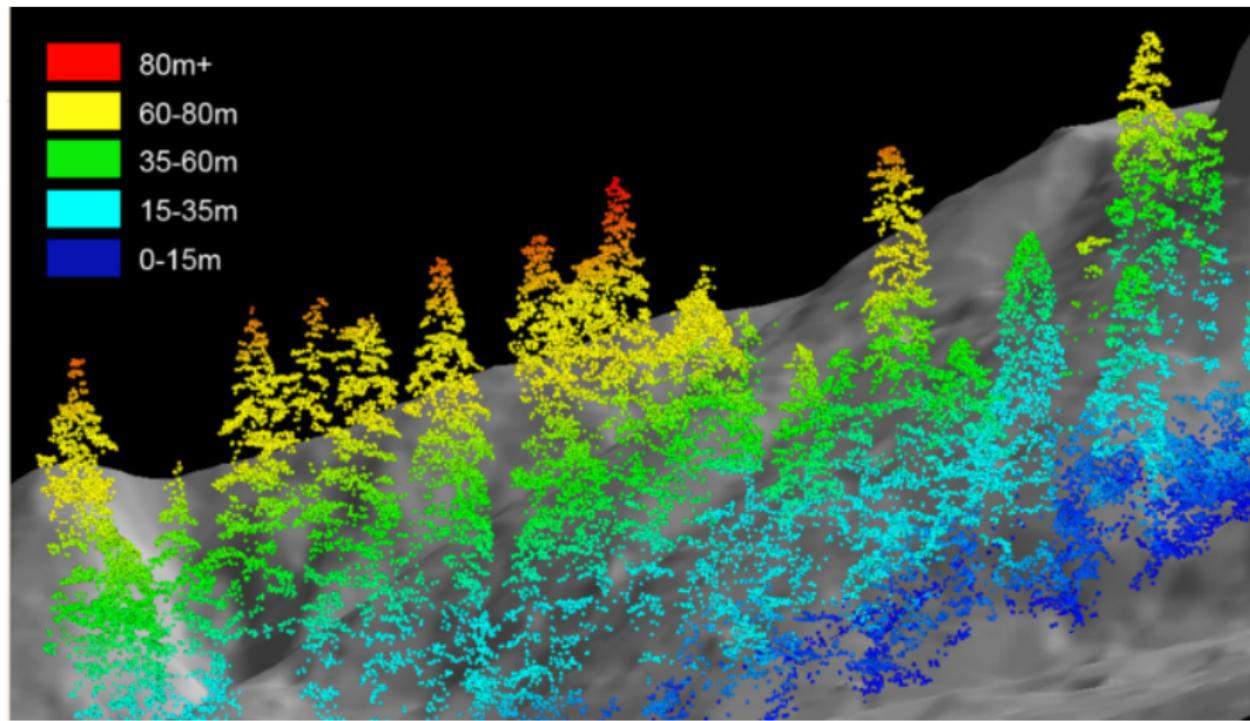


Illustration of LIDAR capture. Source: LIDAR-America.com

LiDAR



LiDAR



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Applications

RS systems, particularly those deployed on satellites, provide a repetitive and consistent view of the earth that is invaluable to monitoring short-term and long-term changes and the impact of human activities.

Applications:

- environmental and monitoring assessment
 - urban growth
 - hazardous waste
- global change detection and monitoring
 - atmospheric ozone depletion
 - deforestation
 - global warming
- agriculture
 - crop condition
 - yield prediction
 - soil erosion

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 - minerals
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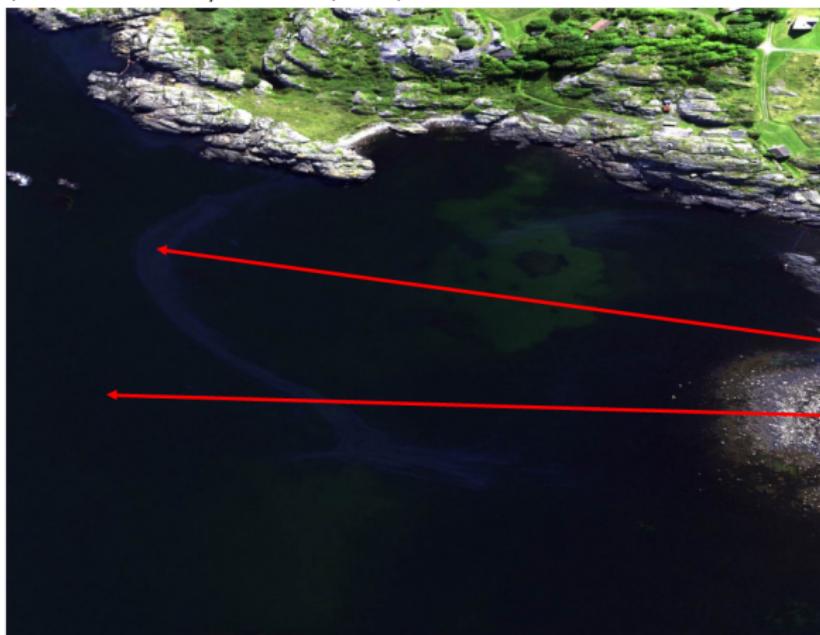
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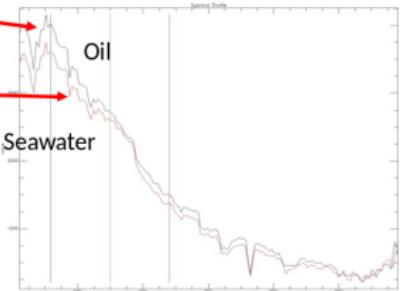
Oil spill detection - MV "Full City" Grounding

(~1000 tons of heavy bunker oil (IF 180) & ~120 tons of marine diesel oil on board)



"norsk
elektro
optikk..

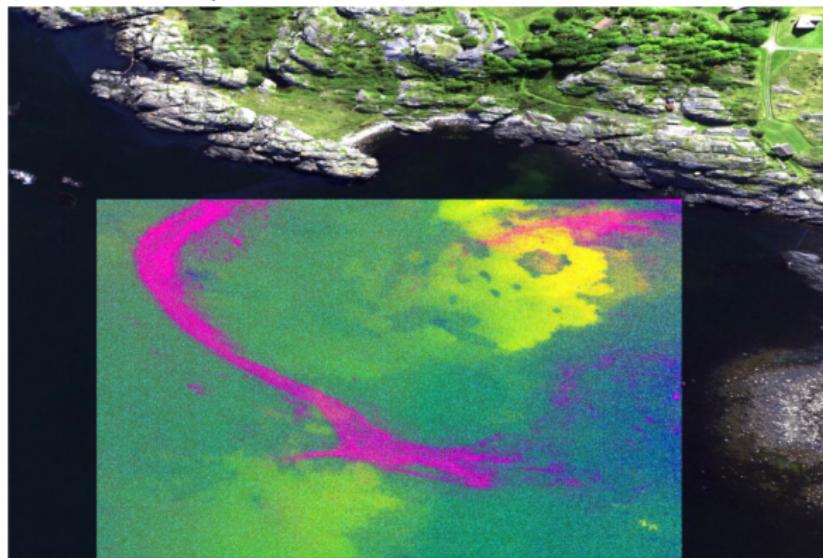
HySpex



Applications

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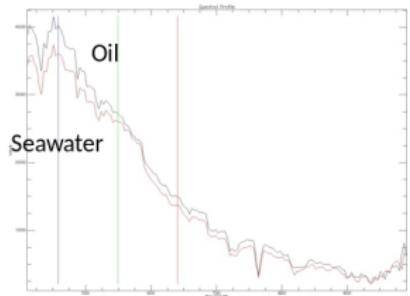
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PCA visualization of oil spill (Pink = oil on seawater, Yellow = sand on sea floor, Green = Seawater).

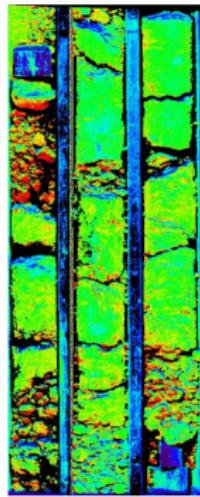
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Applications

Drill Core Imaging

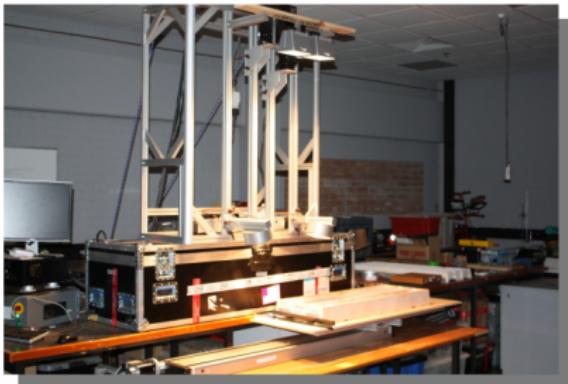


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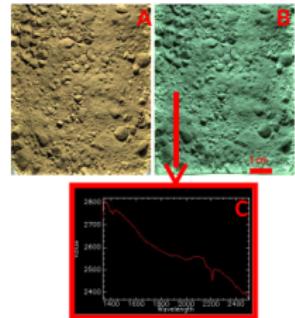
Courtesy of



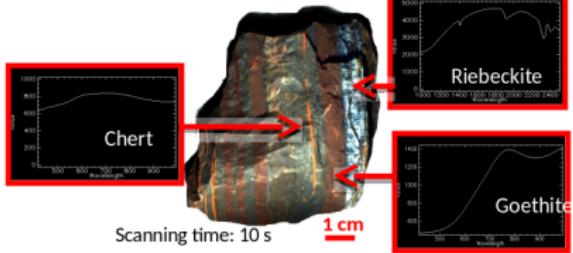
Mineral mapping



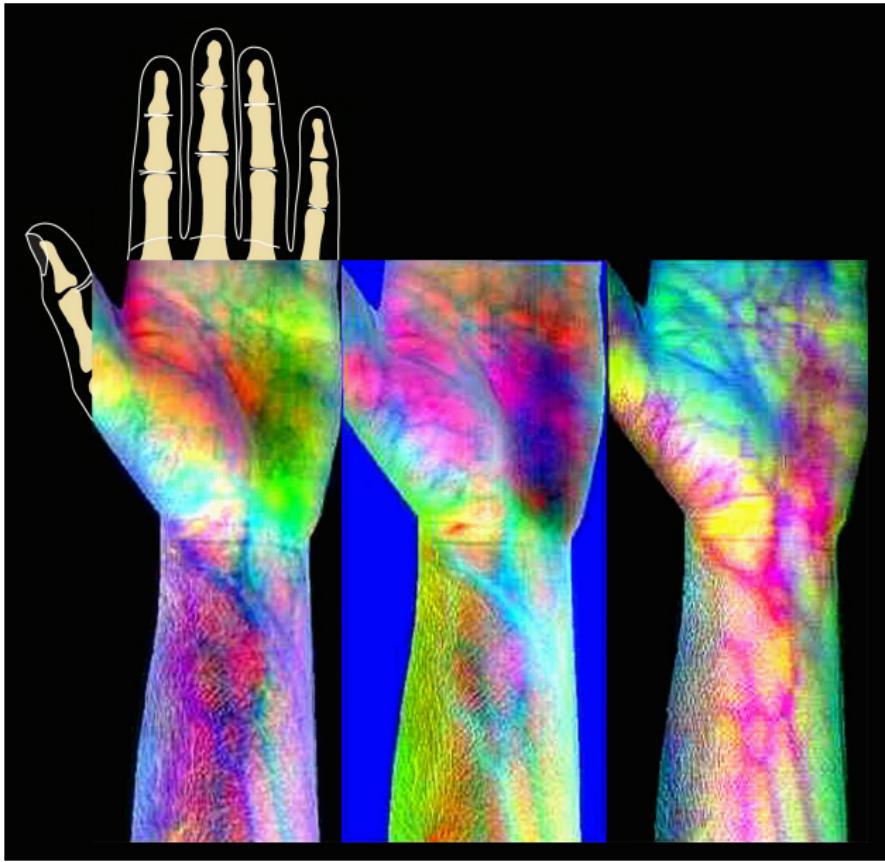
Drill Chips Imaging



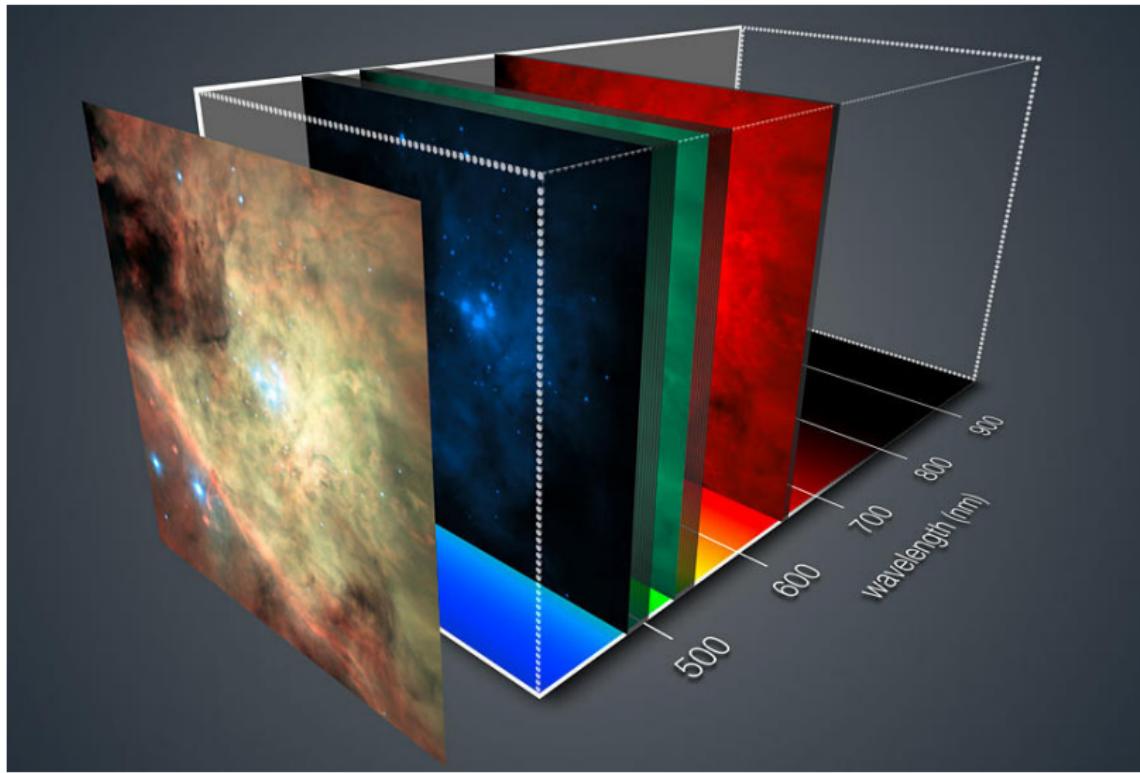
Rock Imaging



Applications

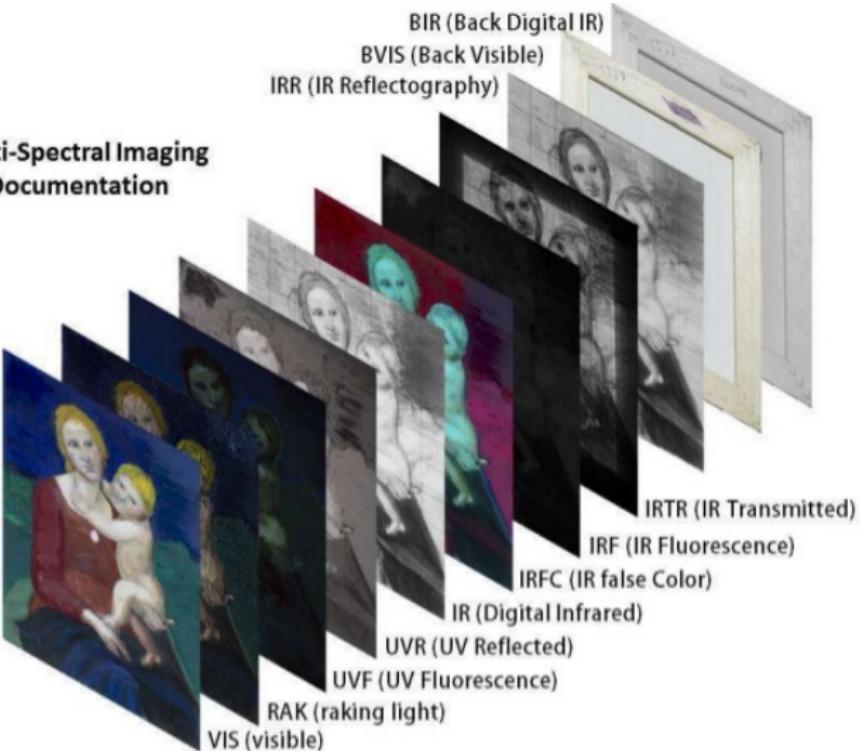


Applications

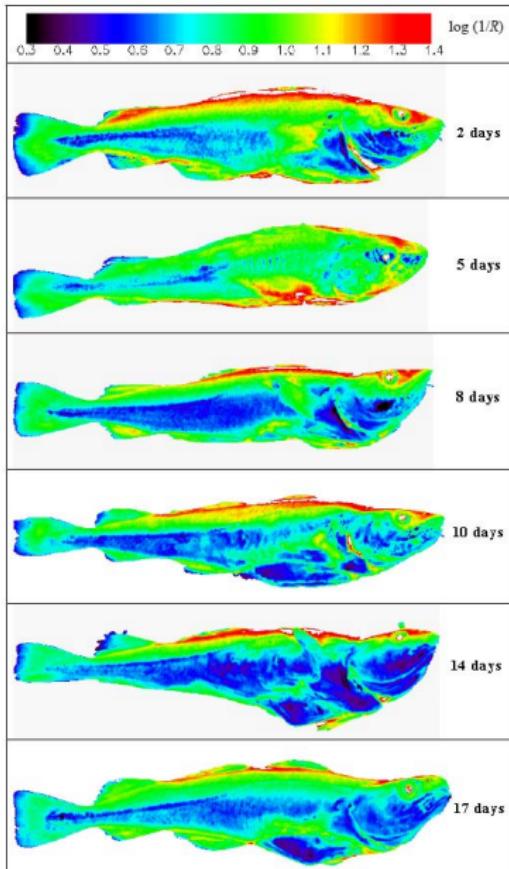


Applications

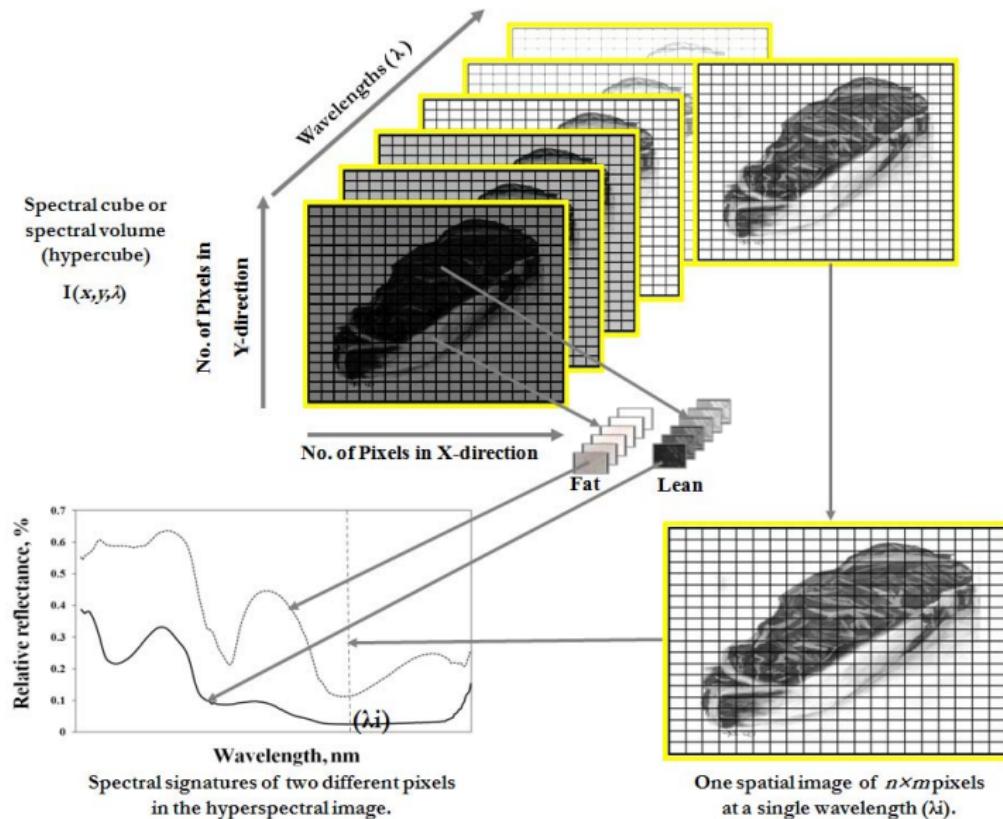
Multi-Spectral Imaging Documentation



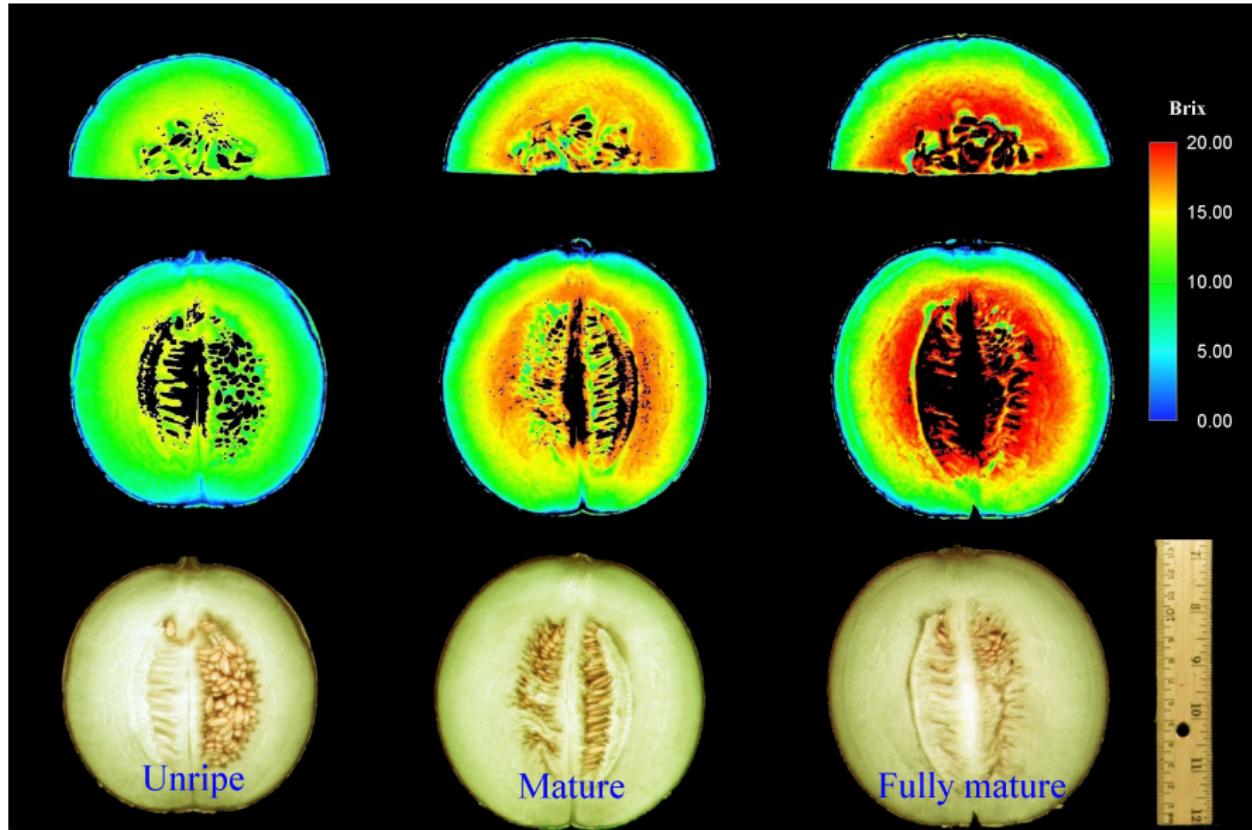
Applications



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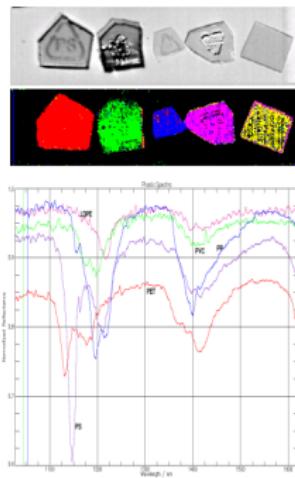


Applications



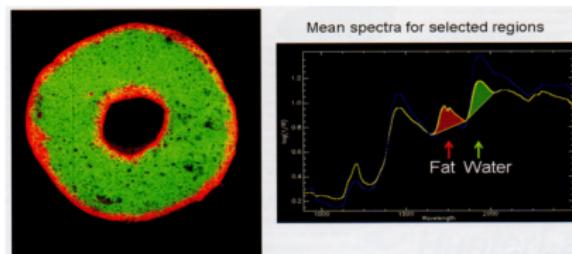
Recycling - Sorting

NIR spectral imaging
Plastics sorting
PS, PET, LDPE, PVC...



Mapping food composition

- VNIR and SWIR range
- Based on C-H, O-H and N-H bonds
- Fat, protein, carbohydrate and water content

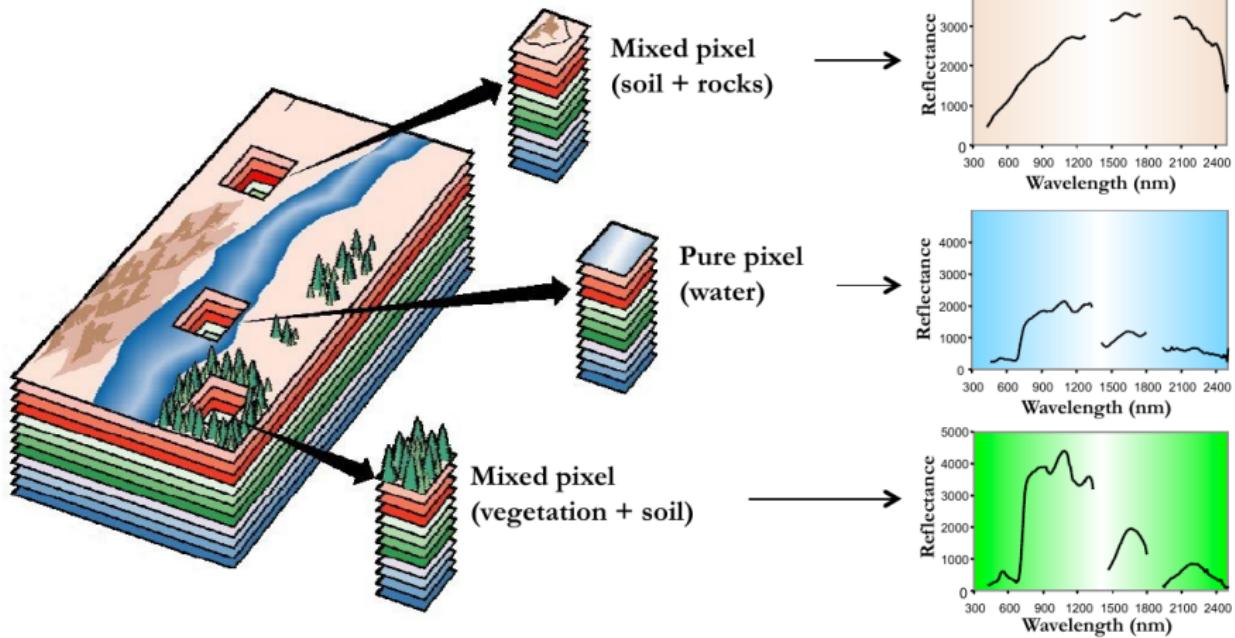


Frying - Fat and Water content in a donut

Reference: CCFRA, Campden, UK

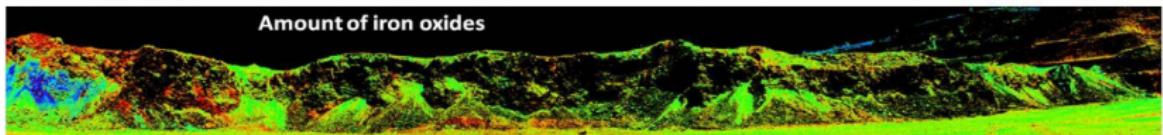
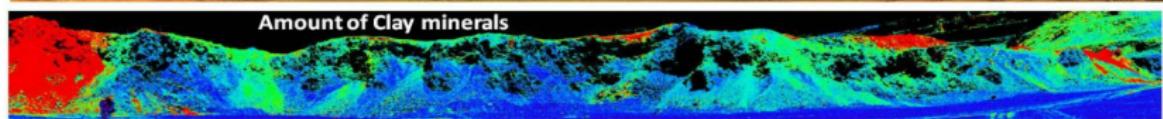


Spectral unmixing



Applications

Spectral Mine Imaging



Courtesy of



- Books

- Richards, Jia, "Remote Sensing Digital Image Analysis - An Introduction" (4th ed, 2006)
- Schowengerdt, "Remote Sensing, Models and Methods for Image Processing" Elsevier 3rd ed. 2007
- Rees, "Physical Principles of Remote Sensing" (2nd ed. 2001)
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- Links to applications

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- <https://www.digitalglobe.com/>

1 Introduction

2 Remote sensing systems

- Optical remote sensing
- LiDAR

3 Remote sensing applications

4 Project