

UNIVERSITY OF TWENTE.



Training Course

Remote Sensing – Basic theory & Image Processing Methods

19 – 23 September 2011

Sensing Electro Magnetic Energy

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FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION





Course: Remote Sensing – Basic Theory & Image Processing Methods - 19 - 23 September 2011

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Overview

- **Measuring radiance**
- **Spectral bands**
- **Classification of RS sensors**
- **Questions**



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Sensing properties

A **remote sensor** is a device that detects, quantifies and records electromagnetic energy.

Examples for daily use:

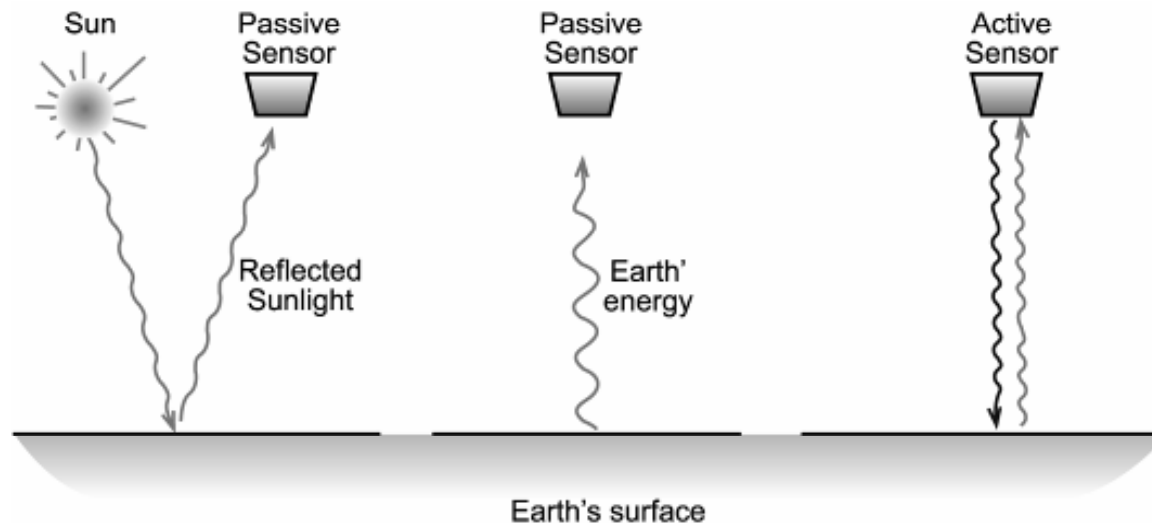
- Camera without flash (passive)
- Camera with flash (active)
- Laser rangefinder (active)



Sensing properties

Most *remote sensors* measure either an *intensity change* or a *phase change* of EM radiation

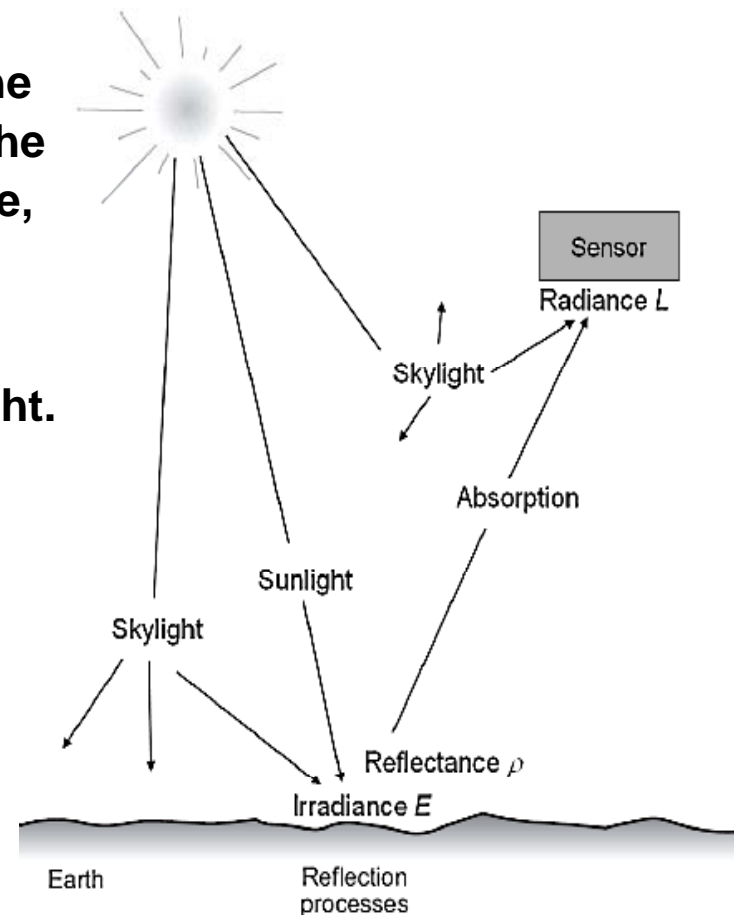
- **Passive sensors**: depend on an external energy source
- **Active sensors**: have their own source of energy



Sensing properties

When sensing reflected light the *radiance* at the detector is the radiance at the earth surface, attenuated by:

- (1) atmospheric absorption &
- (2) radiance of scattered skylight.





Sensing properties – *Spectral band*

A **spectral band** of a remote sensor is an interval of the EM spectrum for which the average radiance is measured.

Examples:

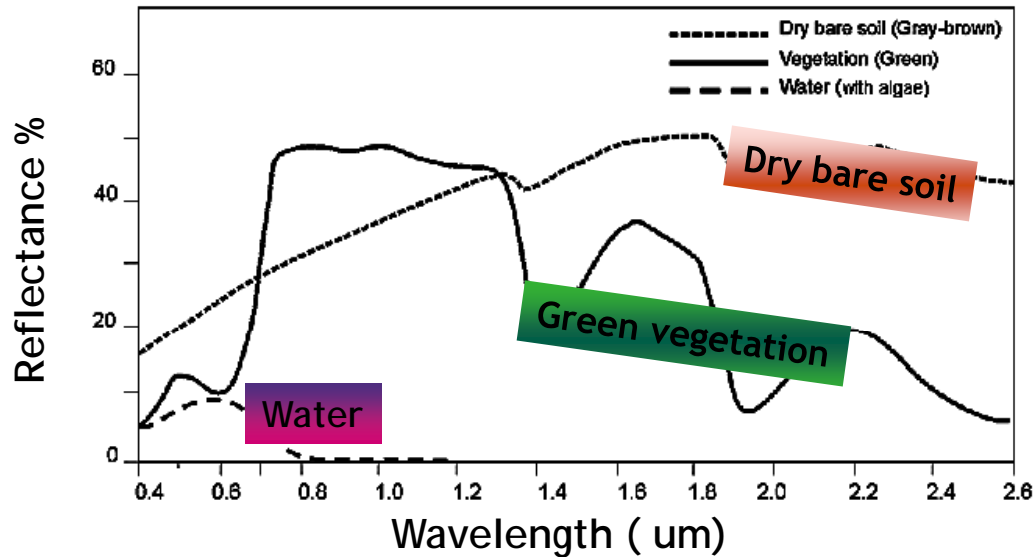
- **Single band**: Panchromatic camera, radar sensor, laser scanner
- **Multi-band**: Multi spectral sensors (“channels”)

Enhanced Thematic Mapper (ETM):

- 1 panchromatic band (image band 8)
- 6 multi-spectral bands (image bands 1-5 & 7)
- 1 thermal band (image band 6)



Reflectance curves



Terra Aster	1	2	3	4	5	6	7	8	9
Landsat-5 TM	1	2	3	4	5	7			
Landsat MSS	1	2	3	4					
Spot XS	1	2	3	4					
Spot PAN	P								

Different sensors have also different Image bands !!



CCD Reflector

Charge-Coupled Device
to measure EM energy.

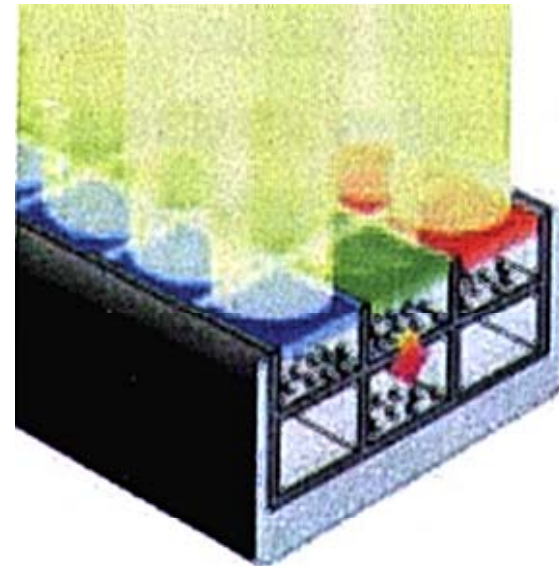
A CCD-array is a line of photo-sensitive,
solid state detectors.

Same as in digital cameras.

First used in SPOT-1 satellite

Charge proportional to radiance at
detector.

Electrical signal sampled and quantized:
Analog to Digital conversion (A / D)



Analog to digital conversion

Output: Digital Number (DN) 8, 16 or 12 bits

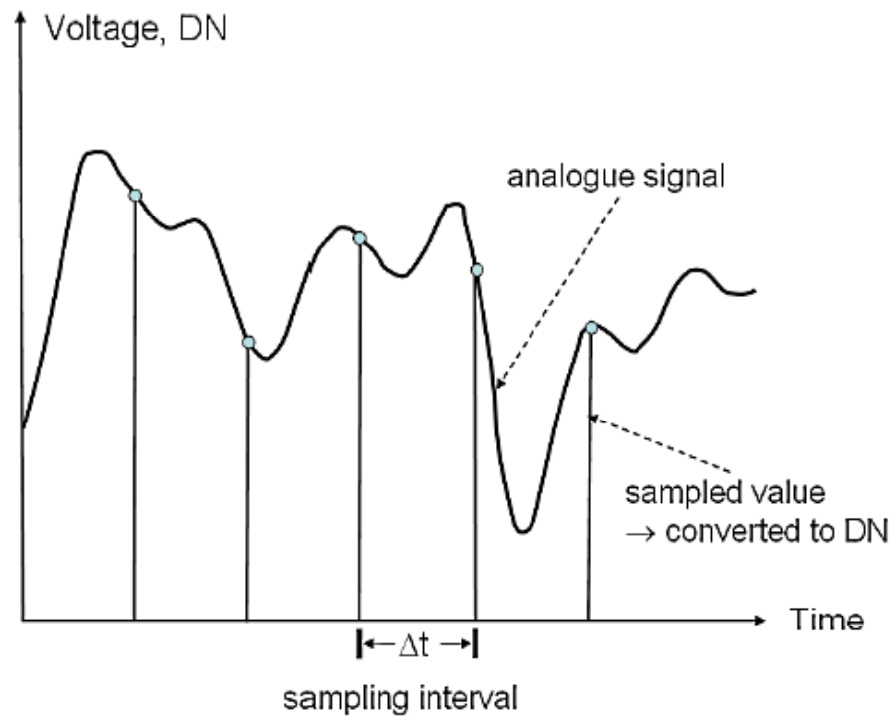


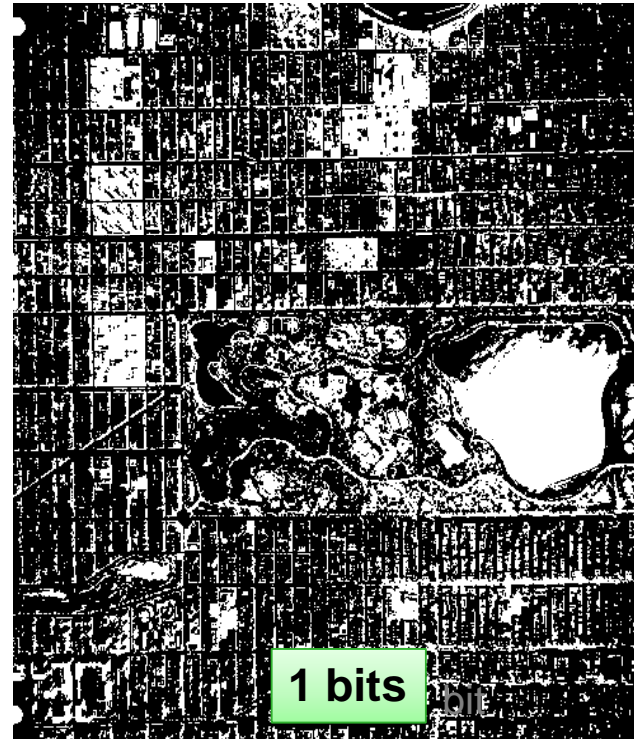


Image data characteristics

Radiometric resolution



8 bits



1 bits



Image data characteristics

Image data are stored in **grid format**: rows and columns

A single element is called a  **pixel** (Picture Element)

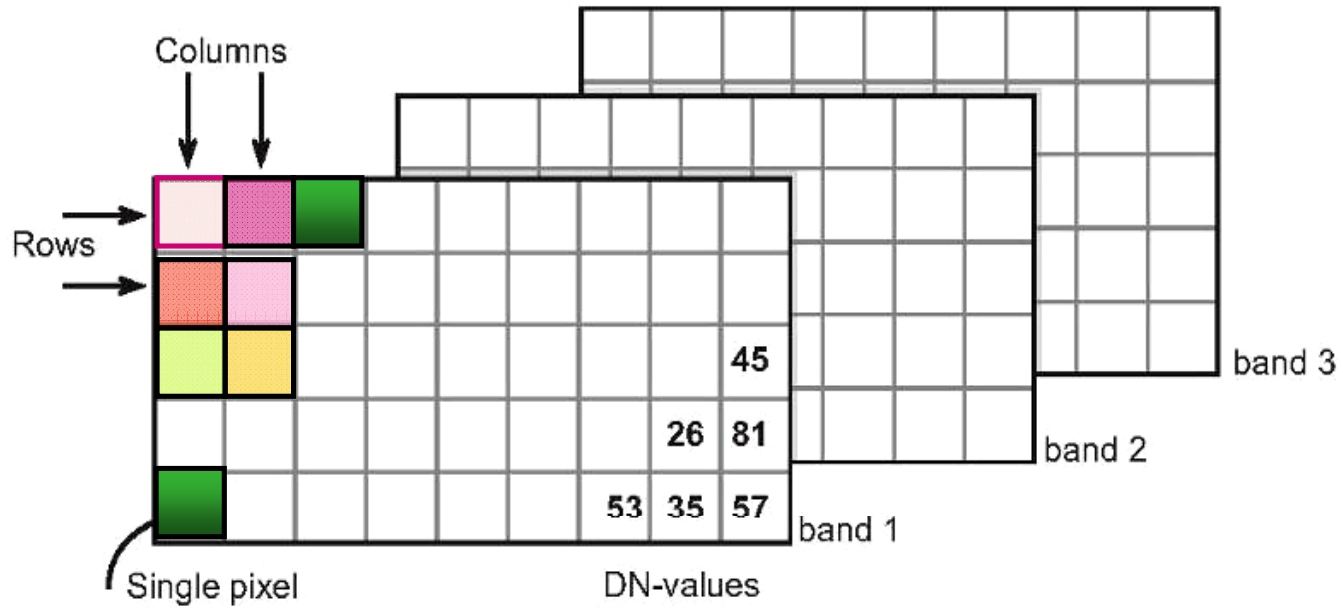




Image data characteristics

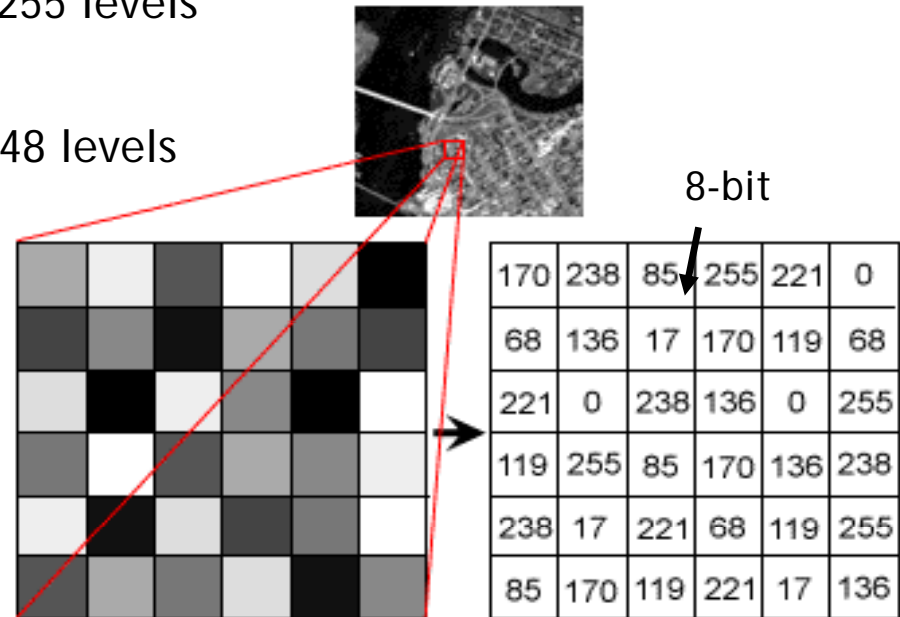
Each pixel has a Digital Number (DN)

8-bit image:

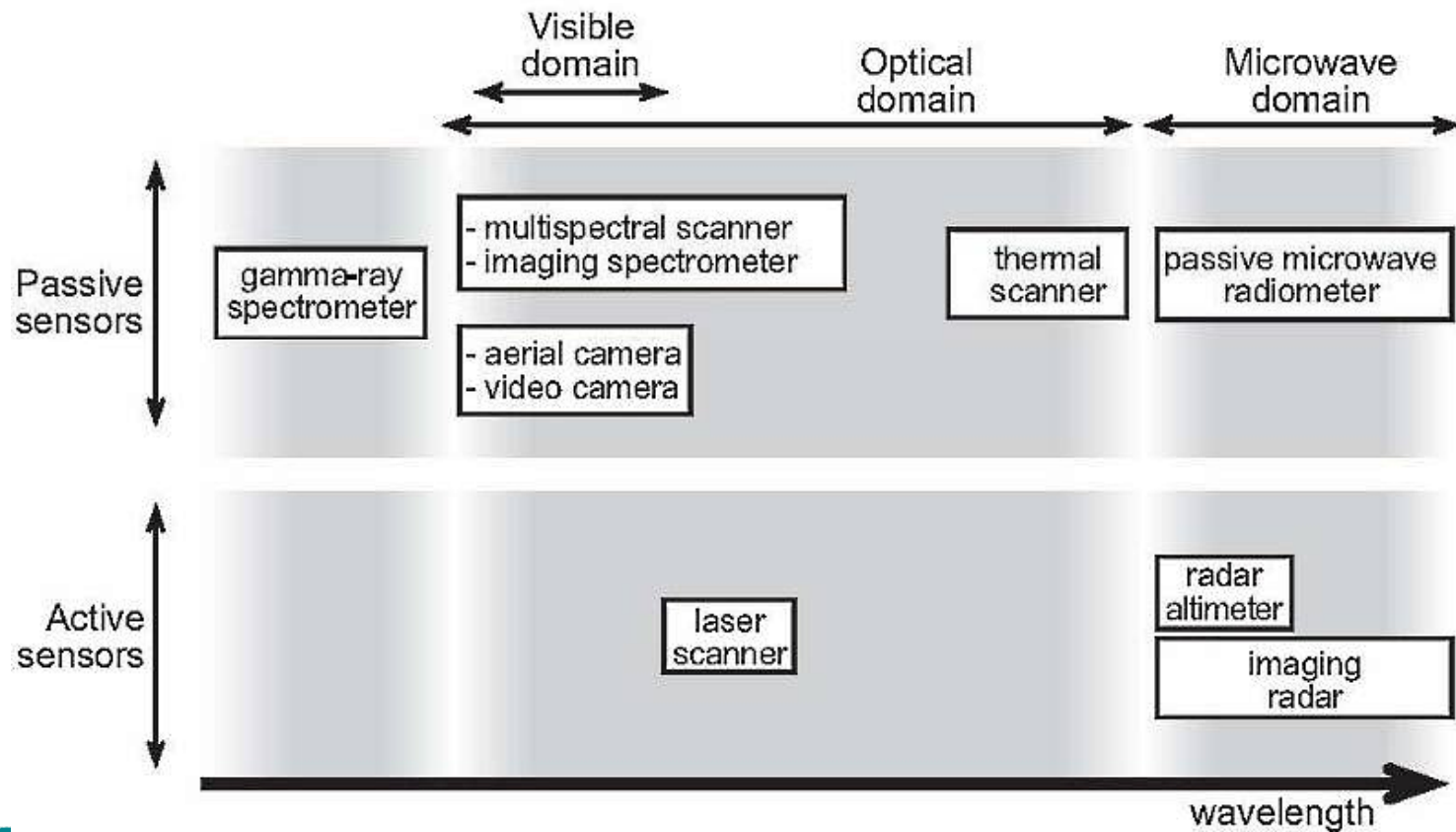
DN values: $2^8 = 0 - 255$ levels

11-bit image:

DN values: $2^{11} = 2048$ levels



Sensor overview

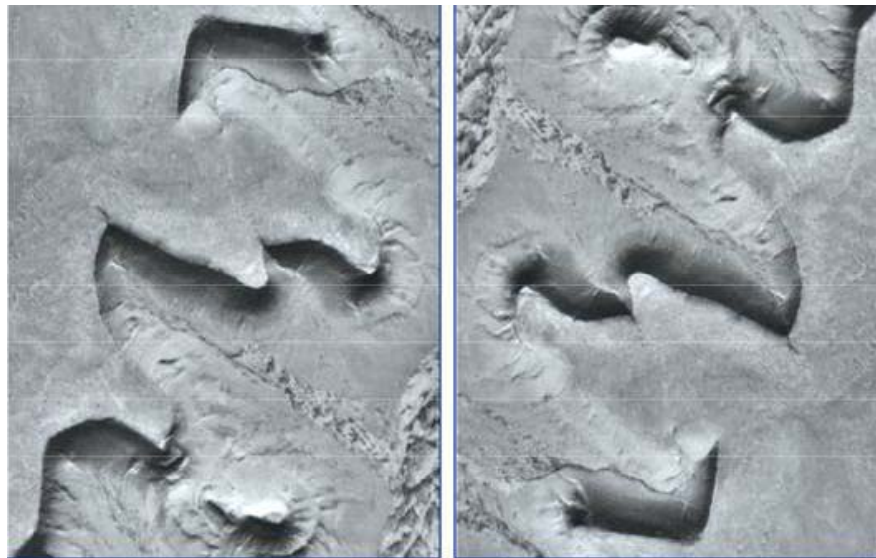




Sensor overview

Aerial film cameras (aerial photos) have been applied from beginning onwards.

Used for large scale topographic mapping and geological / geomorphological interpretations





Sensor overview

Digital cameras & video cameras (ITC RS Book Ch. 4)

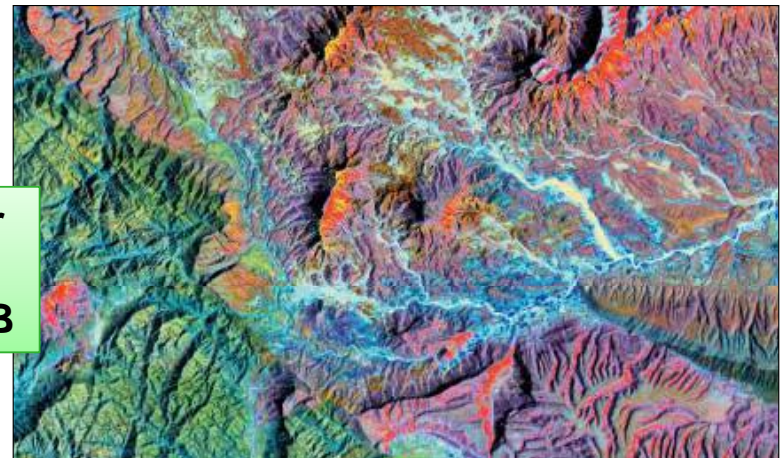
For field photos / films or rapid damage assessment

Multi-spectral scanners (ITC RS Book Ch.4)

Can be applied for many purposes. Some data free or relatively cheap.

Examples: Landsat, SPOT, Aster, IRS, IKONOS, QB, WorldView

Landsat Thematic Mapper
Colour composite
Image bands 4 5 7 : R G B



Sensor overview

Imaging spectrometers (ITC RS Book Ch.13)

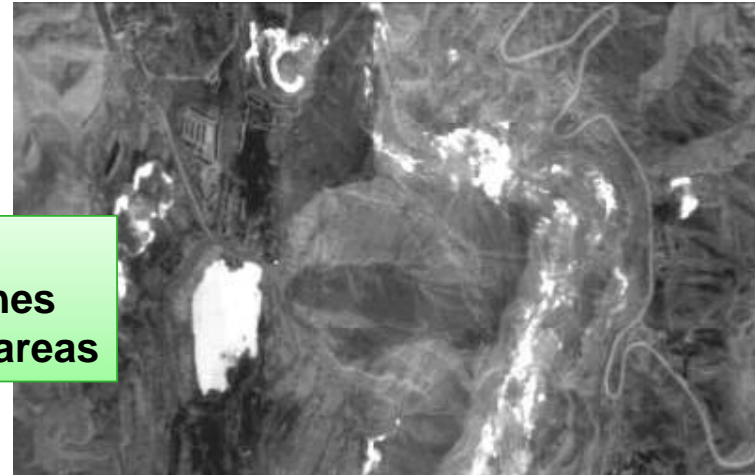
Hyperspectral scanners

Thermal scanners (ITC RS Book Ch. 4 & 12)

Collects data related to object temperatures.

For instance Band 6 of Enhanced TM

**Thermal image of
underground coal mines
Light tones : warmer areas**

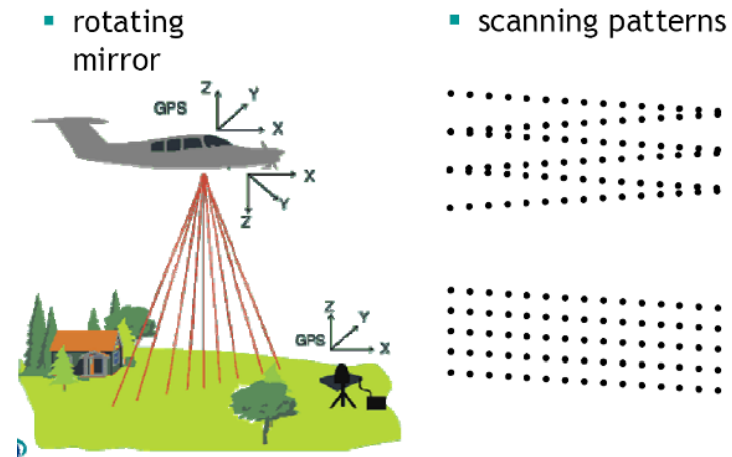


Sensor overview

Laser scanners

Measure distance from a laser instrument to a target (ground surface) in many points.

Also: LIDAR: Light Detection And Ranging.
Can create DTM & DSM



Sensor overview

Imaging Radar (ITC RS Book Ch. 10)

Radar (Radio Detection And Ranging) operates in the spectral domain 10 – 1000 mm.

Active sensors, providing day and night images

Can penetrate clouds.

Air-borne SAR Image.
Tidal inlet & tin mines
Bangka, Indonesia





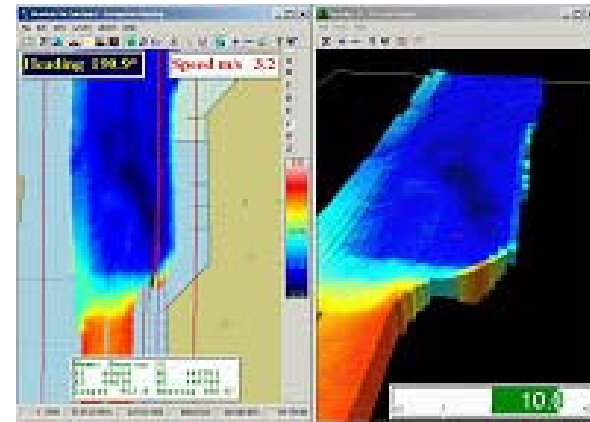
Sensor overview

SONAR

Sound Navigation (SONAR) is an active system for mapping river beds and sea floors.

It works by emitting a small burst of sound from a ship.

The time it takes for the reflected pulse to be received corresponds to the depth of the water.





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QUESTIONS



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