UNIVERSITY OF TWENTE.

Training Course

Remote Sensing – Basic Theory & Image Processing Methods

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Remote Sensing Platforms

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Overview

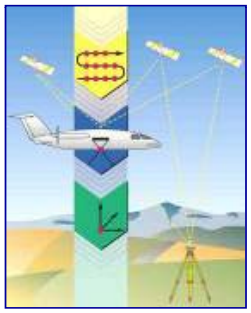
- **Platforms & missions**
  - **aerial surveys**
  - **satellite**
- **Cameras**
- **Scanners**
- **Stereoscopy**
- **Questions**

RS Platforms

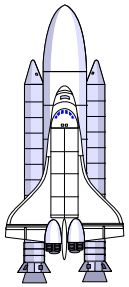
A RS platform is a vehicle, such as a satellite or aircraft that carries one or more RS sensors

Air-borne platforms

(100 m. - 8 km altitude)
aircraft, or helicopter,
microlight, balloon, etc.



Space-borne platforms

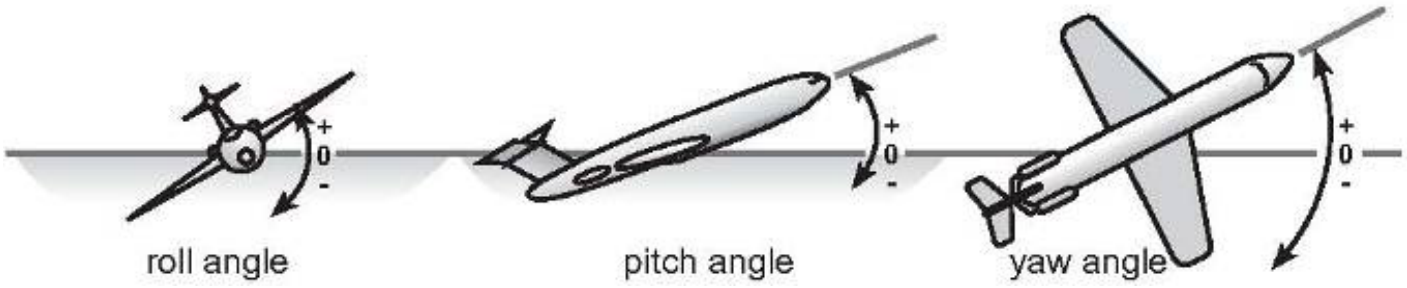


(5000 – 36.000 m. altitude)
Large or small platforms,
Space Shuttle

Aerial Survey missions

Air-borne remote sensing

- **Speed : 150–750 km/hr selected based on sensor system**
- **Altitude : 500 m. up to 8 km. Selection based on image scale.**
- **Sensor position determined by (differential) GPS**
- **Orientation influenced by wind conditions**



Aerial Survey missions

GPS and IMU for *direct sensor orientation*

- **Differential Global Positioning System (GPS)** applied for more precise positioning. Second GPS within 30 km from the aircraft
- **Inertial Measuring Unit (IMU)** measures the attitude angles of the sensor. Assemblage of gyros and accelerometers.

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Aerial Survey missions

Position of the aircraft

+

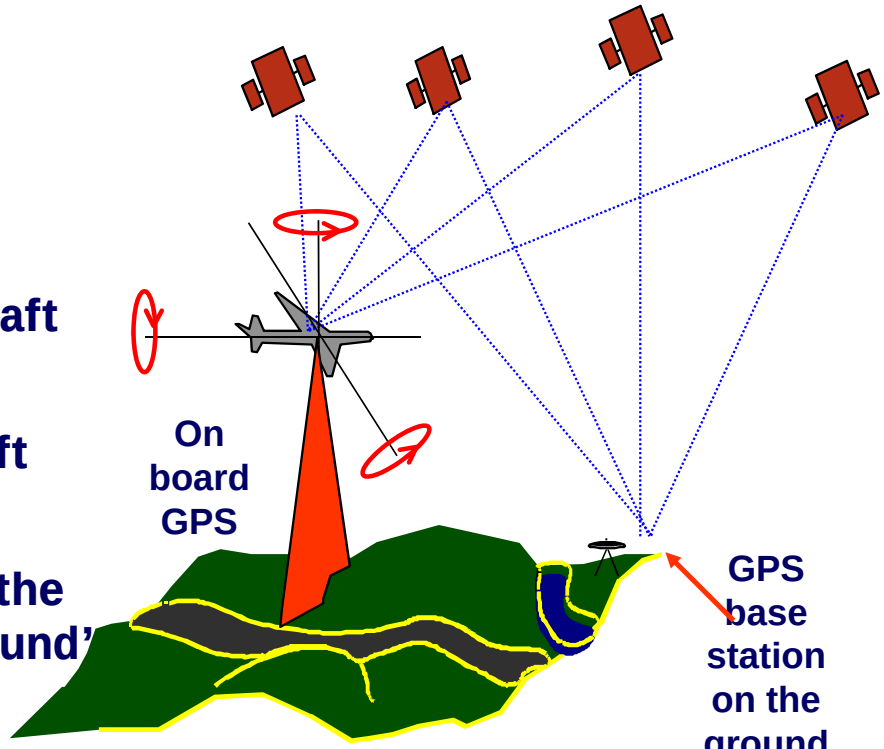
Attitude of the aircraft IMU

+

Distance between the aircraft and the 'ground'

+

Angle under which the distance has been measured



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Geodan geodesie

Aerial Survey missions

Acquisition of overlapping aerial photos

Satellite missions

Orbital characteristics (I):

Orbital altitude **: distance (in km) from the satellite to the surface of the Earth.**

- Low orbit (<1000 km) : Landsat, SPOT, ASTER

- High orbit (36.000 km) : Geostationary

Orbital inclination angle : **angle (in degrees) between the orbital plane and the equatorial plane.**

Determines , together with the field-of-view (FOV) of the sensor the latitudes up to which the earth can be observed

Satellite missions

Orbital characteristics (II):

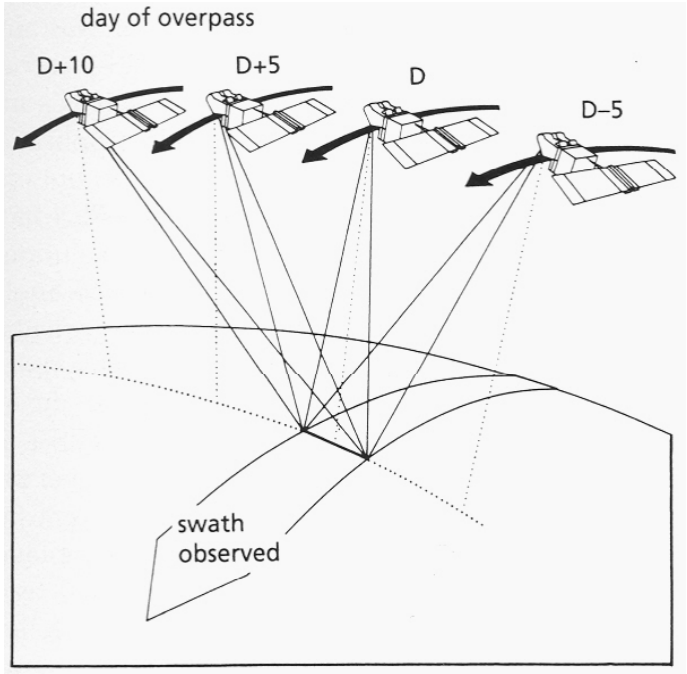
Orbital period **: time required to complete one full orbit.**
Polar satellites: 100 min. at 800 km. altitude

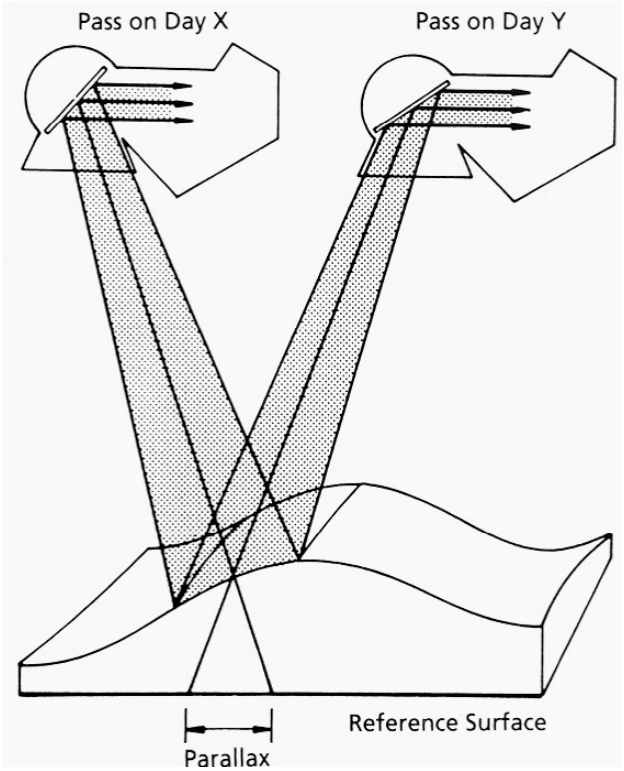
Repeat cycle **: time (in days) between two successive identical orbits.**

Revisit time **: time between two subsequent images of the same area, also dependent on the pointing capability of the sensor (for instance SPOT)**

Satellite missions

SPOT : increased revisit times due to side looking





Figures: Drury, Image Interpretation in Geology

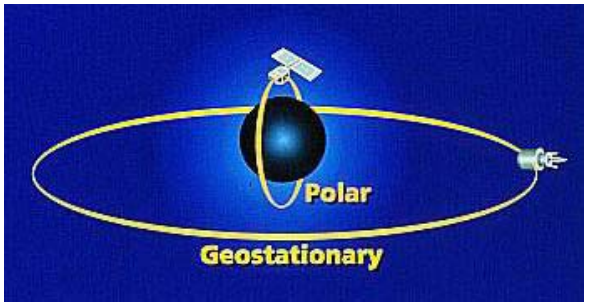
Satellite missions

Orbital types

Polar orbit **: orbit with inclination angle between 80 and 100 degrees**

Sun-synchronous orbit **: near-polar orbit chosen in such a way that the satellite passes overhead at the same time : Landsat, SPOT, IRS, ASTER.**

Geostationary orbit **: satellite placed above equator at an altitude of approx. 36.000 km.**



Satellite missions

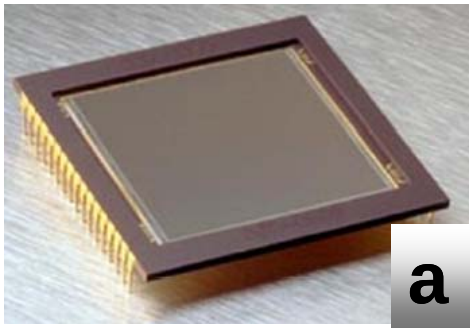
Market figures

- Currently around 20 space-borne optical sensor systems operational
- Three radar based space-borne systems available
- Various civil RS satellite launched every year
- Aerial survey oldest RS technique
- New types of sensors:
  - air-borne laser scanners
  - air-borne hyper-spectral sensors

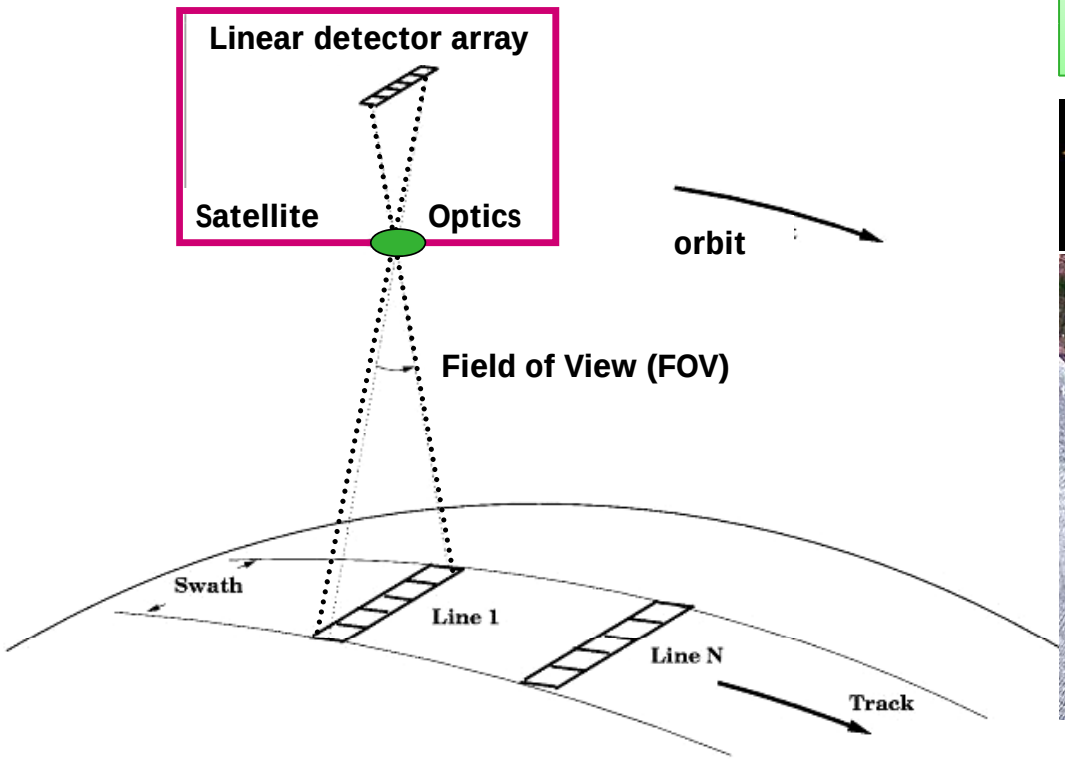
Satellite missions

Digital cameras

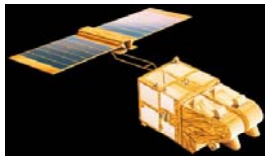
- A digital camera is an electro-optical remote sensor
- The CCD array can either be an assembly of linear arrays or a matrix array.
- Three channels for Red, Green and Blue colours
- Matrix array used for small format frame cameras (a)
- Linear array used for moving RS sensors (b)



Satellite missions - *Linear array sensor*

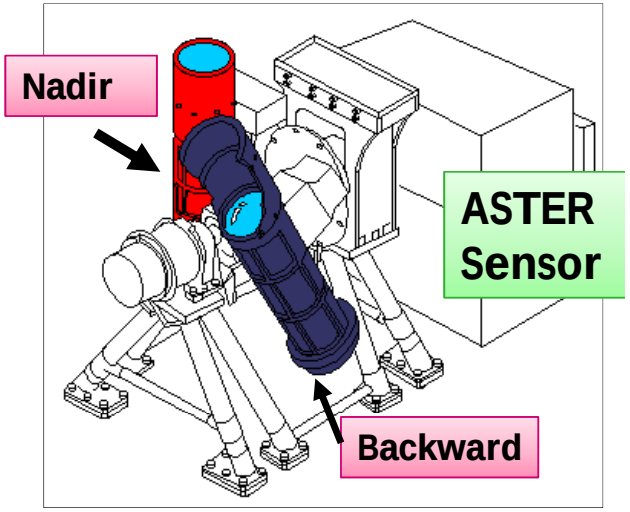


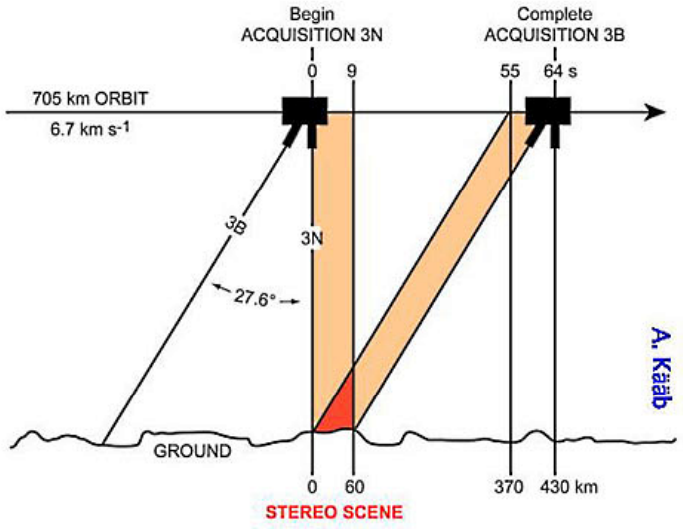
First satellite with line camera : SPOT 1 (1986)



Satellite missions - *Linear array sensor*

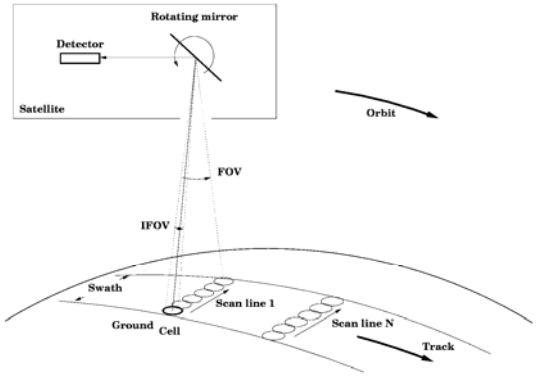
- **The Aster has two sensors in the VNIR: one "nadir" looking and another one "backward" looking**
- **Stereo images can be produced in ASTER using both nadir and backward looking images**

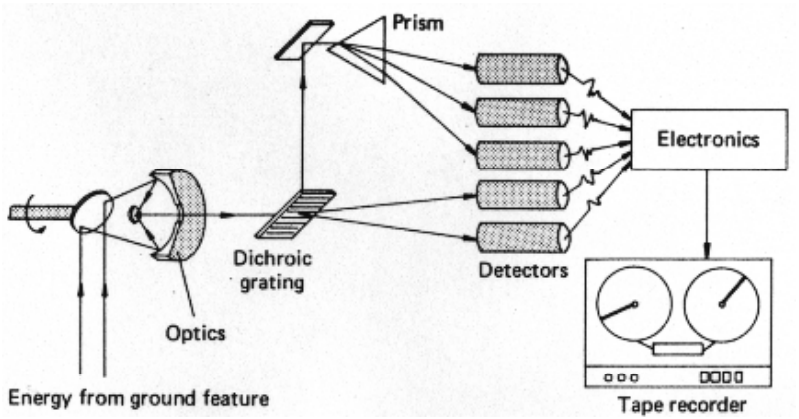




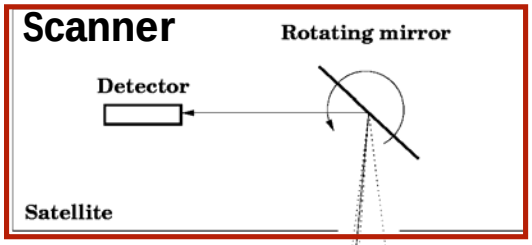
RS Scanners

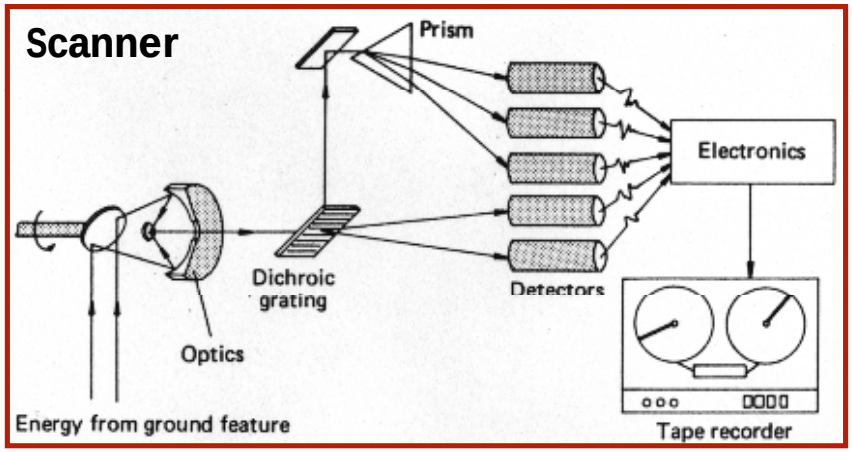
- **Electro-optical RS with a mechanical component.**
- **IFOV: Instantaneous FOV (2.5 mrad or less).**
- **Use in VIS, NIR, TIR**
- **One detector per band and a prism splits the light into wavelengths.**

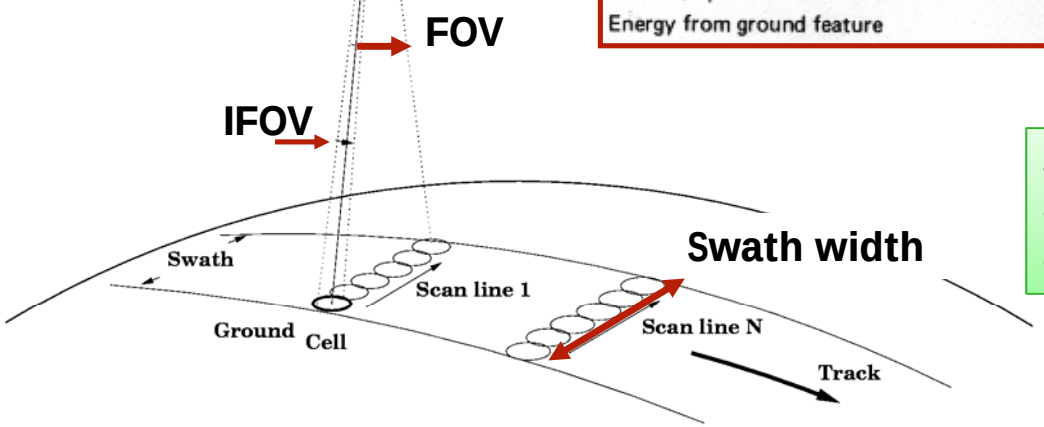




RS Scanners





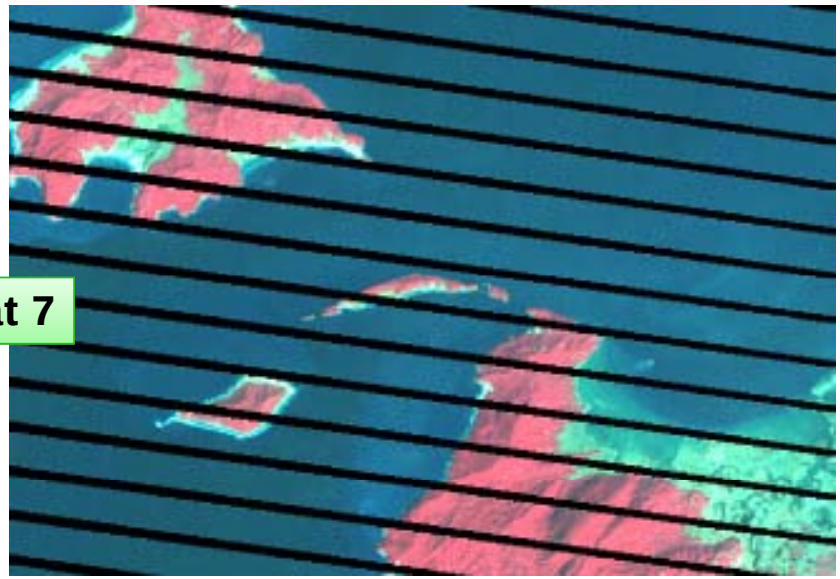


Swath widths
- **Landsat : 185 km**
- **Aster: 60 km**

RS Scanners - *Problems*

Problem: different *CCD*s in the array may be degrade or be out of order

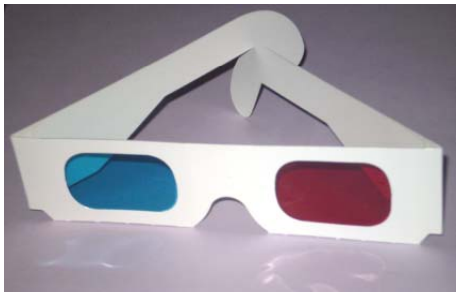
Regular calibration needed

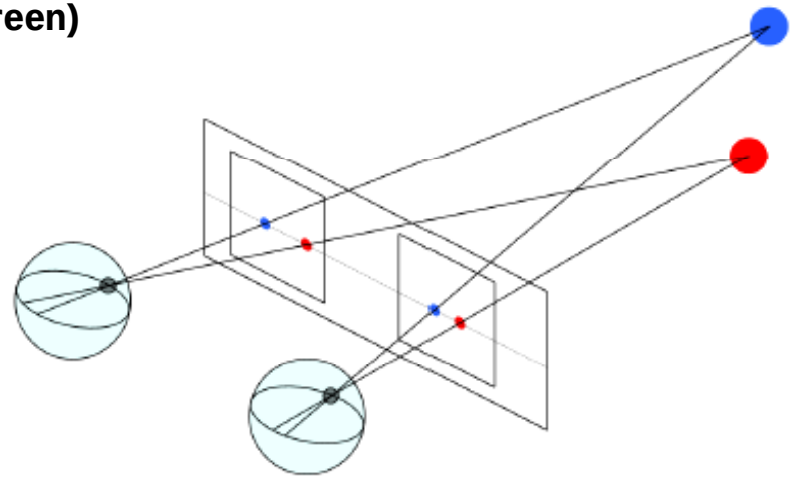


Stereoscopy – anaglyph vision

Science of producing three-dimensional (3D) visual models

- **Basic requirements: images of the same object from two different positions**
- **Can be viewed at the computer screen**
- **Anaglyph : red & blue (or green)**

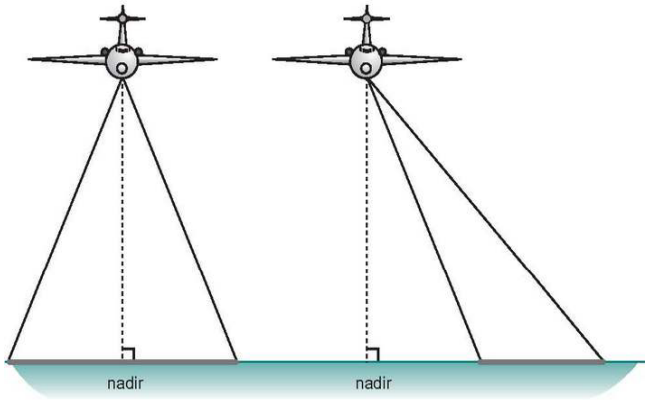




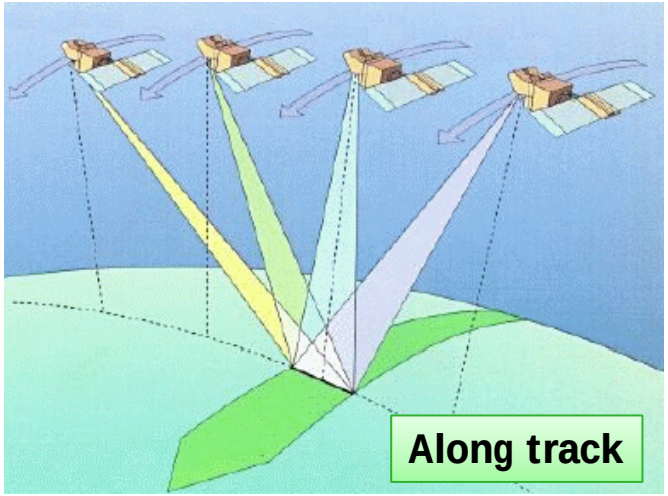
Stereoscopy (2) - *screenscope*

- In ILWIS software 3D visualization possible by combining
  a. overlapping aerial photographs
  b. drape of image over DEM
     Examples:
     - Landsat & SRTM
     - Aster VNIR & DEM
     - "Google" image & Lidar

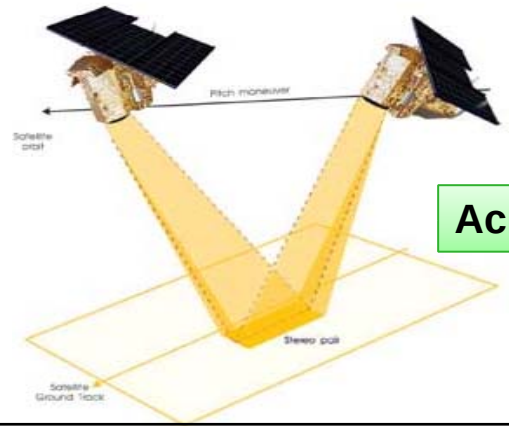
Stereoscopy – Remote sensors



Aerial photos



Along track



Across track

Questions