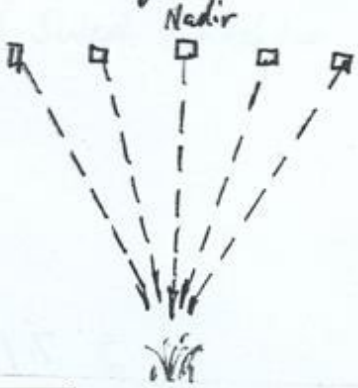
2.6 Temporal Resolution

Cycle

- Orbital Revisit (~~Cycle~~)
  - → Ground Track (~ 2,700 Km Apart)
  - → Landsat 16 days, Spot 26 days
- Target Revisit
  - → Target
  - → Landsat (Nadir) 16 days
    Spot (off-Nadir) 3-4 days (Taiwan)
  - → Change Detection



Frame Camera

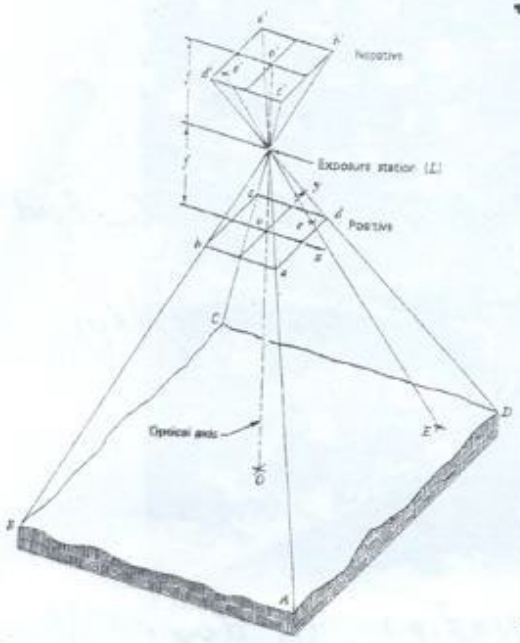


Figure 3.6 Basic geometric elements of a vertical photograph.

Lo O → 垂線 Nadir

LaA, LbB, ···

·· LeE 皆為直線

→ 共線方程式

→ 2維中央透視投影

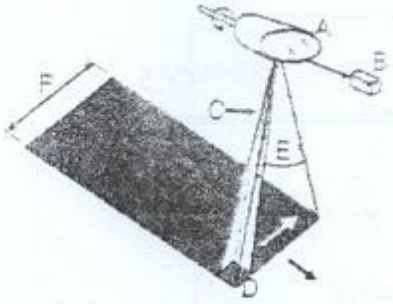
(2D Central Perspective)

→ Uniform Spatial Resolution

(IFOV smallest at Nadir, largest near the edge)

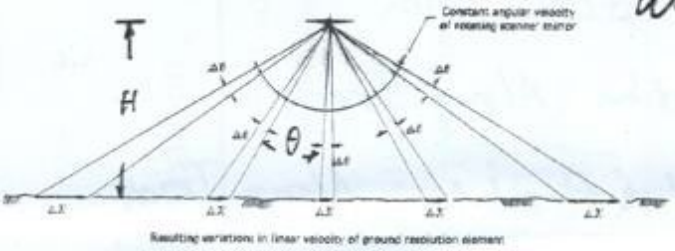
2.7.1

Across Track Scanners
(Wickbroom Scanners)



Across-track scanners

→ Pixel Scanning
→ Constant IFOV
→ Best resolution at Nadir
Worst near the edge



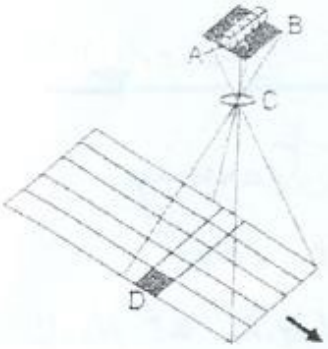
Resulting variations in linear velocity of ground resolution element

$$\Delta X(\theta=0) = H \cdot \Delta\theta$$

$$\Delta X(\theta) = \Delta X(\theta=0) / \cos^2\theta$$

$$F \text{ (Swath Width)} = 2 \cdot H \cdot \tan\frac{E(FOV)}{2}$$

Along Track Scanners
(Pushbroom Scanners)



Along-track scanners

→ Central Perspective Across Track

→ Uniform Spatial Resolution Across Track

→ Parallel Projection Along Track

→ Uniform Spatial Resolution Along Track

Sensor Comparison

Item \ Sensor	Frame Camera	Across-Track (whiskbroom)	Along-Track (Pushbroom)
Imaging	2D	Pixel by Pixel 1D → Mirror Oscillating 1D → Flight	1D → CCD Array 1D → Flight
Exposure Time	Very Short	Long + Long	Very Short + Long
Image Geometry	2D Central Perspective	Angular	1D Central Perspective 1D Parallel
Image Quality Geometry	Excellent	Poor	Good

2.8.3

Thermal scanners became commercially available during the late 1960s. Earlier models used only direct film recording for image generation. Newer systems record data digitally. In addition, scan line output signals are generally monitored in flight on an oscilloscope or some other real-time monitor. Present-day systems are capable of temperature resolution on the order of 0.1°C.

Figure 5.22 illustrates schematically the basic operation of a thermal scanner system, in this case an across-track scanner. The system works as

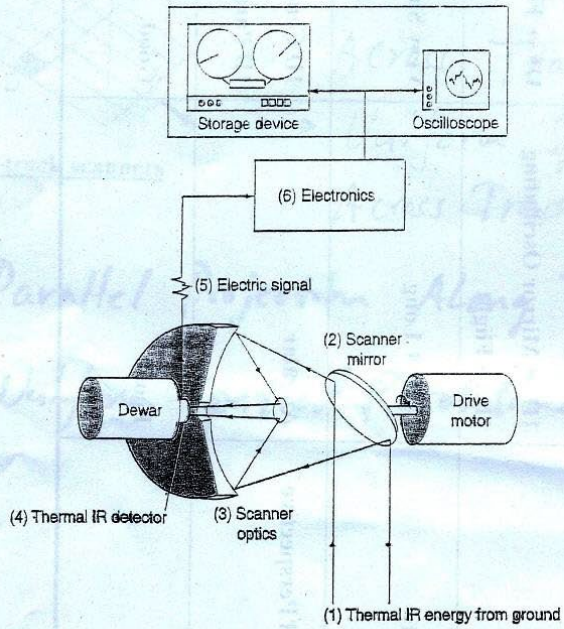


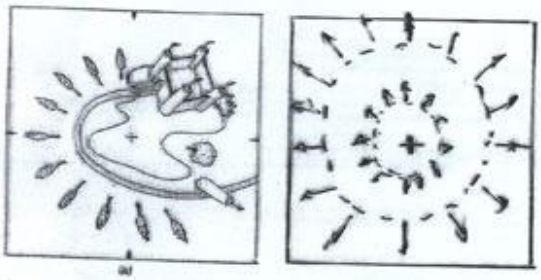
Figure 5.22 Across-track thermal scanner schematic.

2.9.1

2.10 Geometric Distortion in Imagery

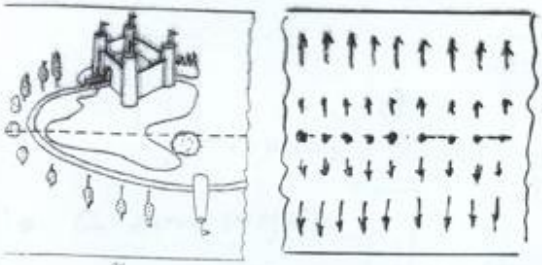
- Perspective of sensor optics
- Motion of scanning system
- Motion and stability of platform
- Platform altitude, attitude and velocity
- Terrain relief
- Curvature & rotation of Earth

Relief Displacement



Frame Camera

- Displace radial from center
- The higher the target } larger displacement
  The farther away from center }

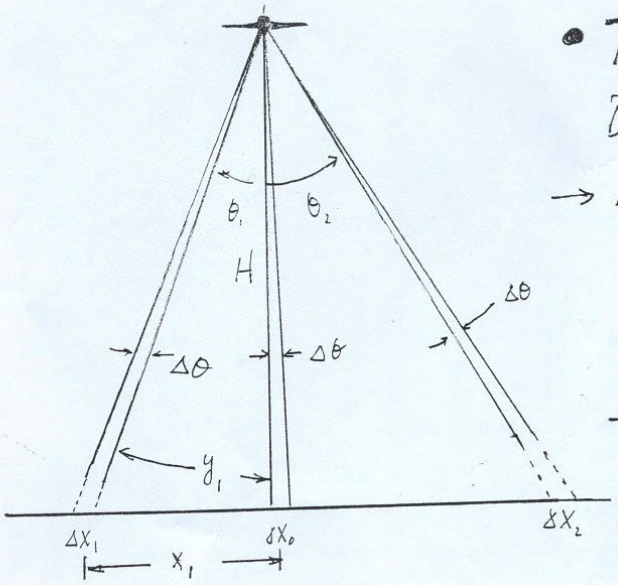


ALong Track Scanner

- Displace ⊥ flight line
- The higher the target } larger
  The farther away from } displacement
  the flight line

2.10.1

Across-track Scanners



- Tangential Scale Distortion

→ Location

$y_1 = H \cdot \theta_1$ → Image

$X_1 = H \cdot \tan\theta_1$ → Ground

→ Resolution

$$\Delta X_1 = \frac{\Delta X_1}{\cos\theta_1^2}$$

$\Delta y_1 = H \cdot \Delta\theta$

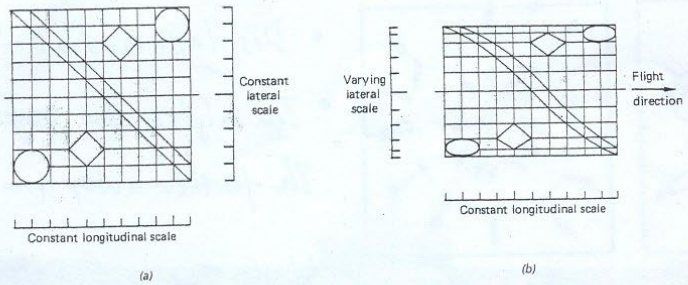


Figure 5.12 Tangential-scale distortion in unrectified across-track scanner imagery: (*a*) vertical aerial photograph; (*b*) across-track scanner imagery.

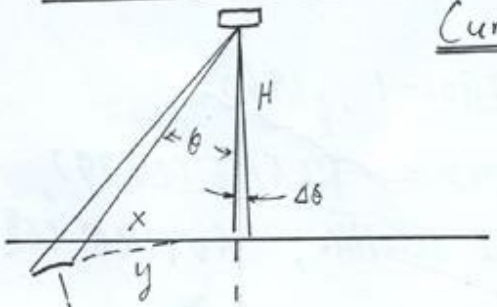
- Relief Displacement

Similar to Along-track Scanner

2.10.2

Curvature and Rotation of the Earth

Curvature



- Location

$X = H \cdot \tan\theta \rightarrow$ Image

$y = R_E \cdot \left(\tan^{-1}\frac{X}{R_E}\right) \rightarrow$ Ground

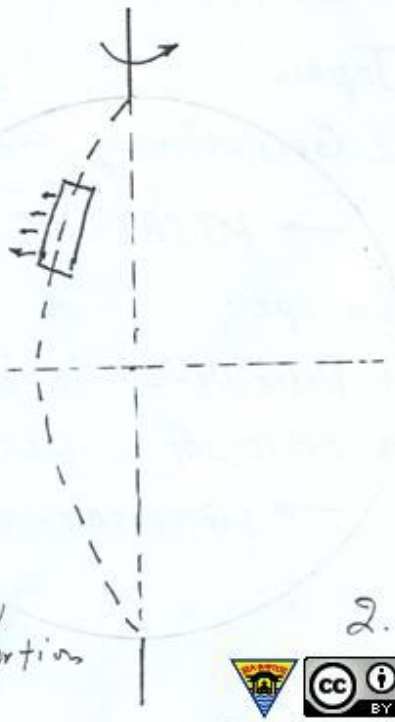
- Resolution

$\Delta X = \frac{\Delta\theta}{\cos^2\theta}$

Δy : complicated

R_E (Earth Radius)

Rotation



- Along the Track

- On earth surface

West ← → Skew Distortion

2.103

2.11 Weather Satellites / Sensors

* USA

1. Polar Orbit: TIROS-1, 1960

→ NOAA-1 (1970) → NOAA 6 (1979),
First Operational Satellite, AVHRR (後詳

2. Geostationary Orbit: ATS-1, 1966

→ GOES-1 (1975)

→ GOES-East (75° W); GOES-West (135° W)

→ GOES-13 (2006)

* Japan:

2. Geostationary Orbit: GMS-1, 1977

→ MTSAT-2 (2006)

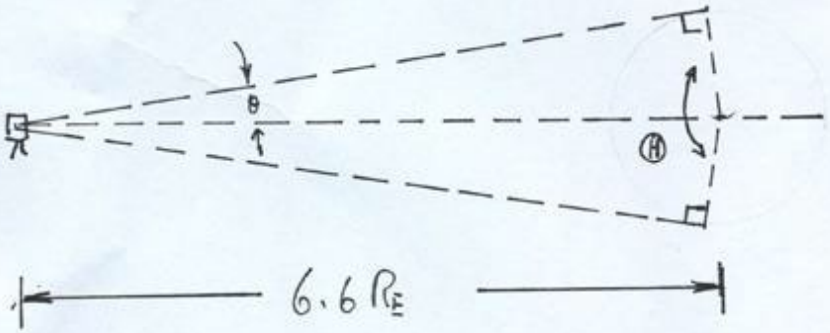
* Europe:

1. Polar Orbit: to be launched in 2010

2. METEOSAT: METEOSAT-1, 1977

→ METEOSAT-7, 1997-2013

Geostationary



$$\theta = \sin^{-1}\frac{1R_E}{6.6R_E} \simeq \frac{1}{6.6}\ \text{radian} = 8.7^\circ$$

(Note: $\sin\theta \simeq \theta$ if $\theta \leq 1$ (radian)
$\cos\theta \simeq 1 - \frac{\theta^2}{2}$)

$$Ⓗ = 180^\circ - 2\theta \simeq 163.6^\circ$$

2.11.2