Digital elevation models

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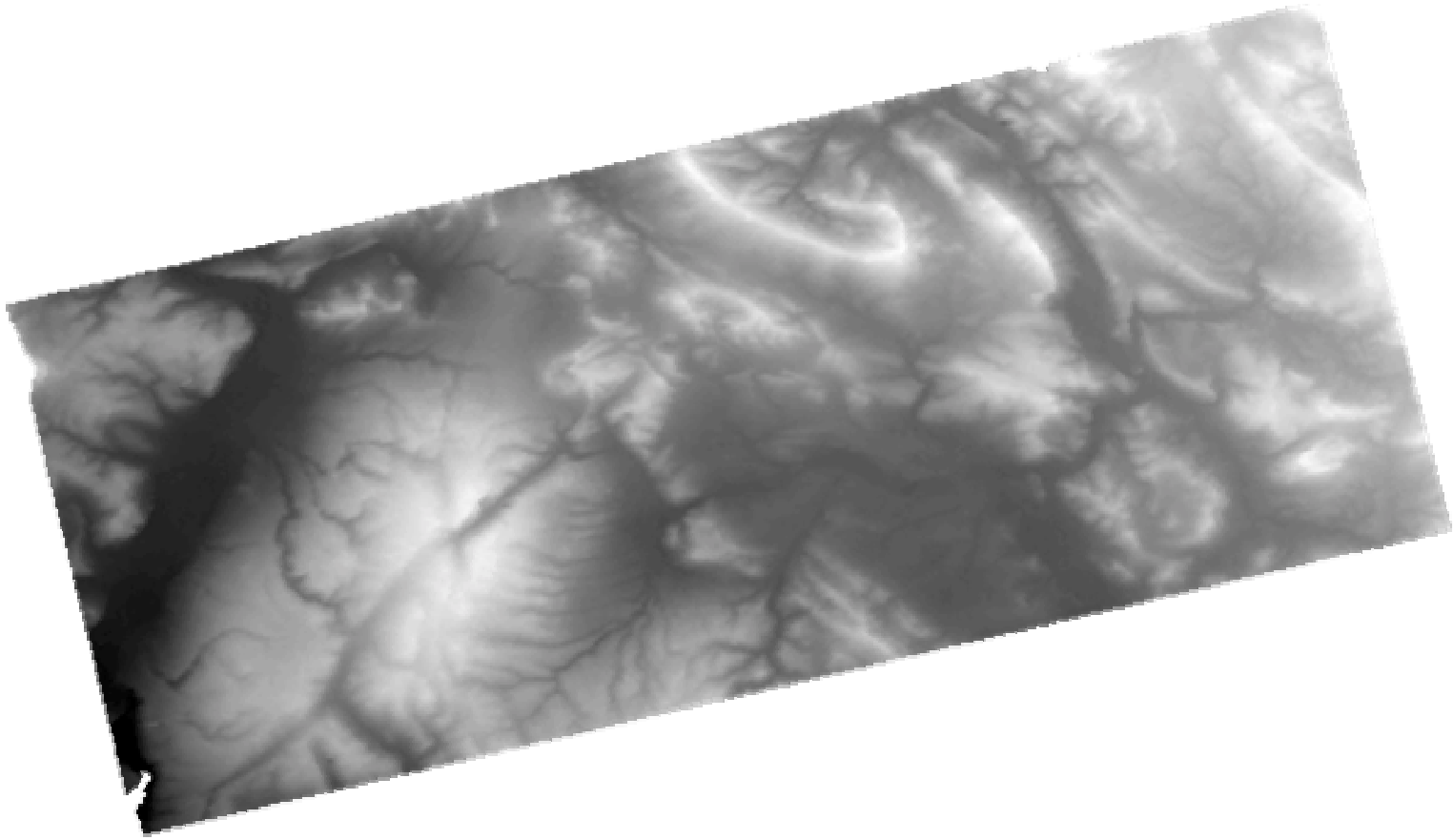
Outline

- Representations
- Applications for digital elevation models
- Issues for choosing the right technique
- Techniques for creating DEMs
- Problem of quality control
- Quality measures
- Current status

Representations

Digital elevation models



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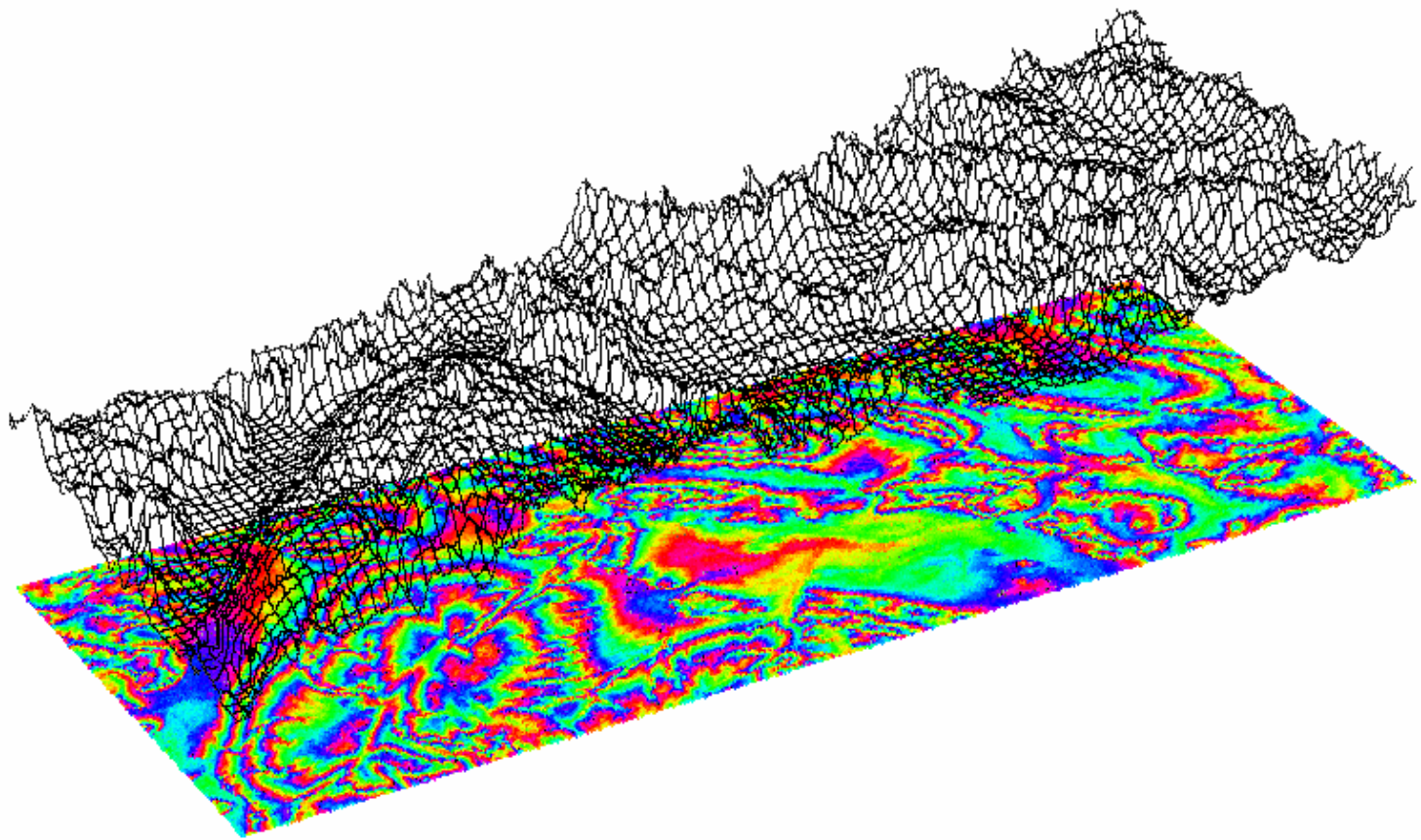
Representations



Digital elevation models

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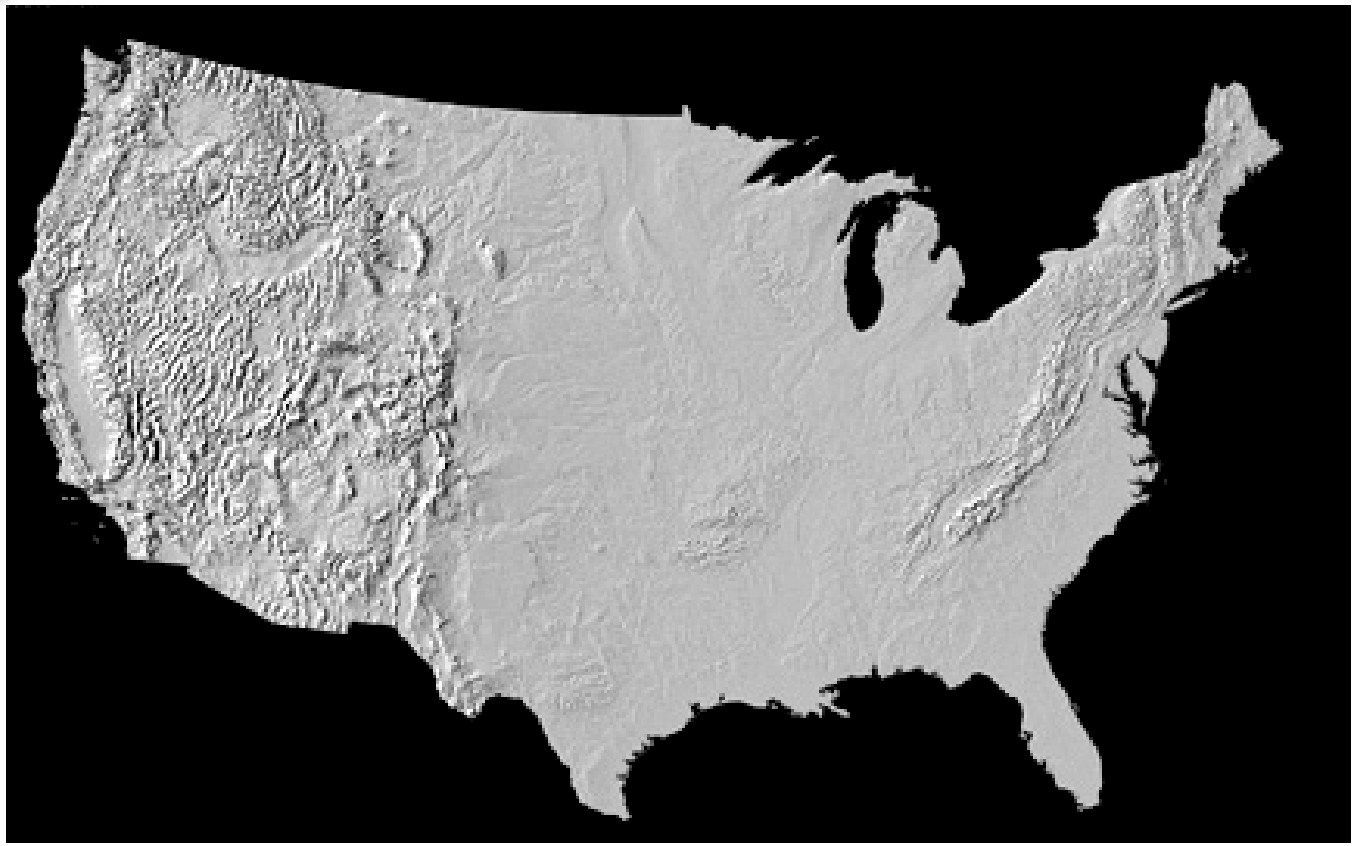
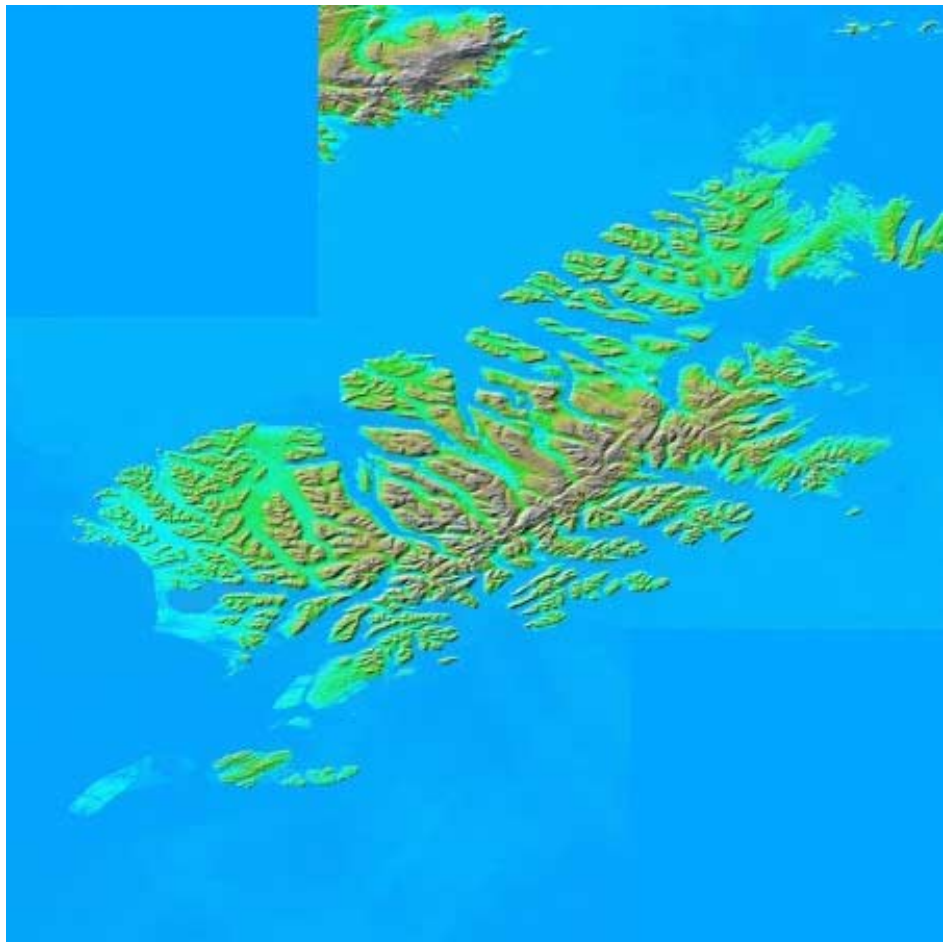
Representations



Source: NASA Remote Sensing Tutorial (http://rst.gsfc.nasa.gov/)

Representations



Digital elevation models

Source: USGS EROS Data Center
(ftp://edcsgs9.cr.usgs.gov/pub/data/srtm/)

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Applications for DEMs

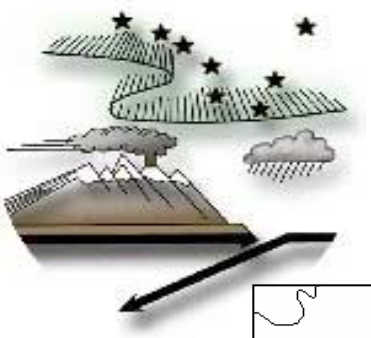
- topographic mapping
- geomorphological studies (slope, aspect)
- info layer in geographical information systems
- telecommunication
- aviation
- geometric correction of image data

Issues

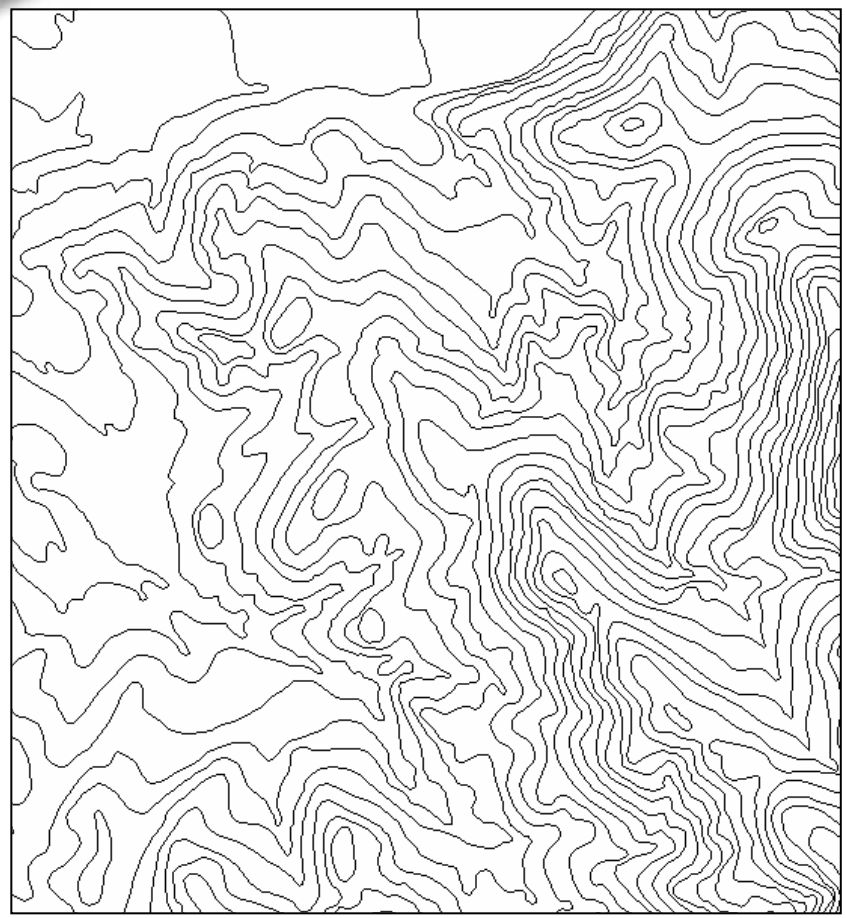
- size of the area to be covered
- accuracy required
- acquisition costs (satellite vs. airborne vs. field)
- time factor
- accessibility of terrain
- cloud coverage for remote sensing
- verification of data quality

Techniques for creating DEMs

- Digitizing contour lines
- Aerial photogrammetry
- Stereoscopy using optical satellite imagery
- Laser scanning
- Radar techniques

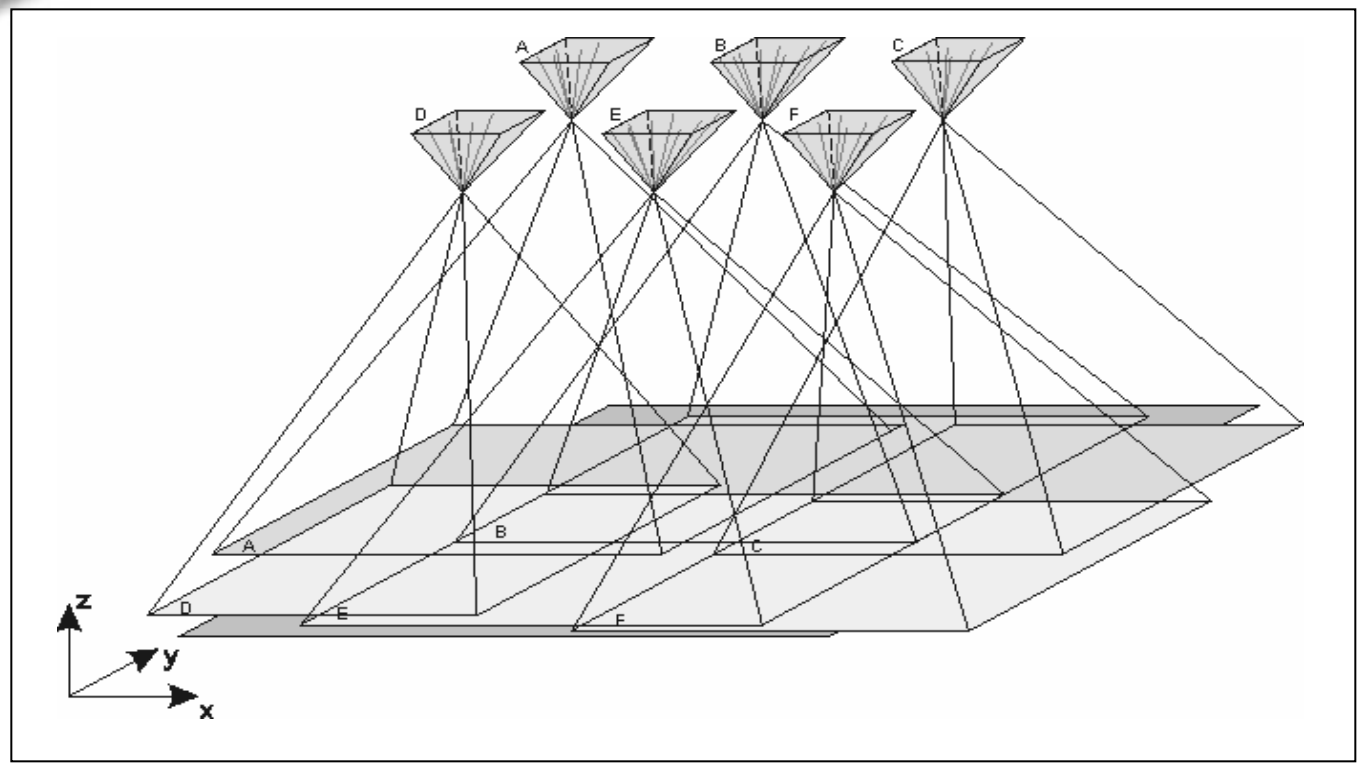


Digitizing contour lines



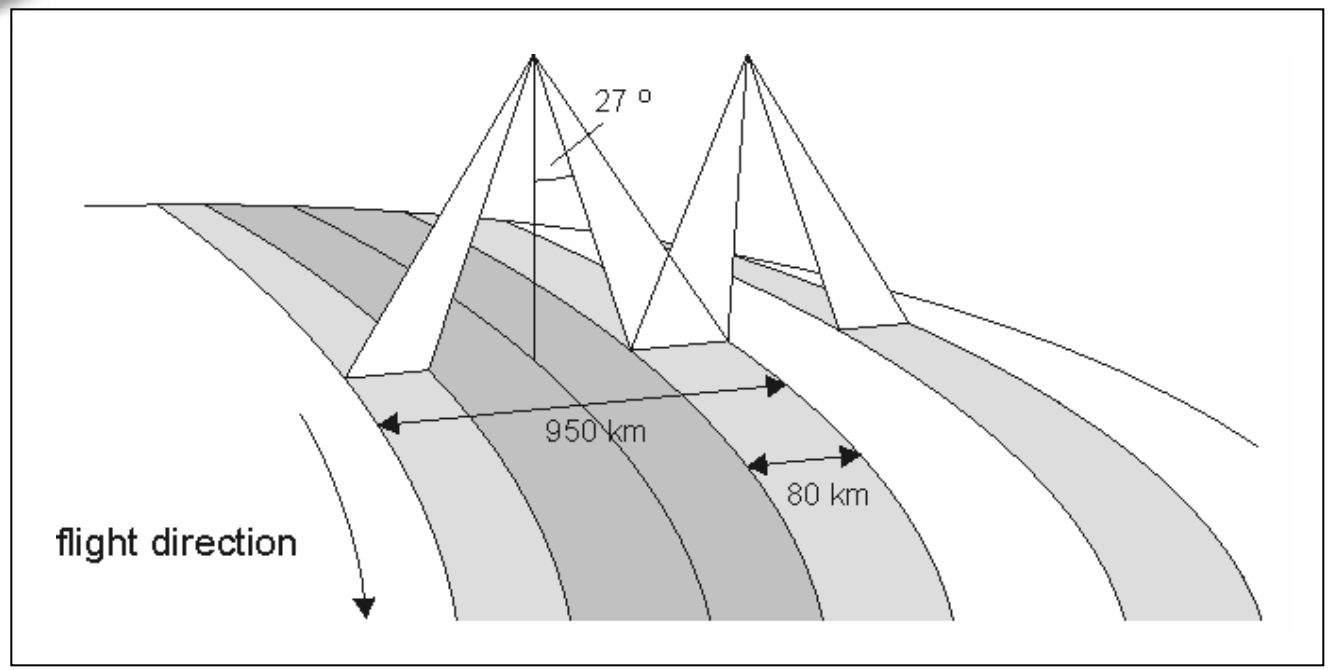
- derived from existing topographic maps
- various interpolation methods
  - weighted moving averages
  - bicubic splines
  - finite elements
- still the main source for creating DEMs

Aerial photogrammetry



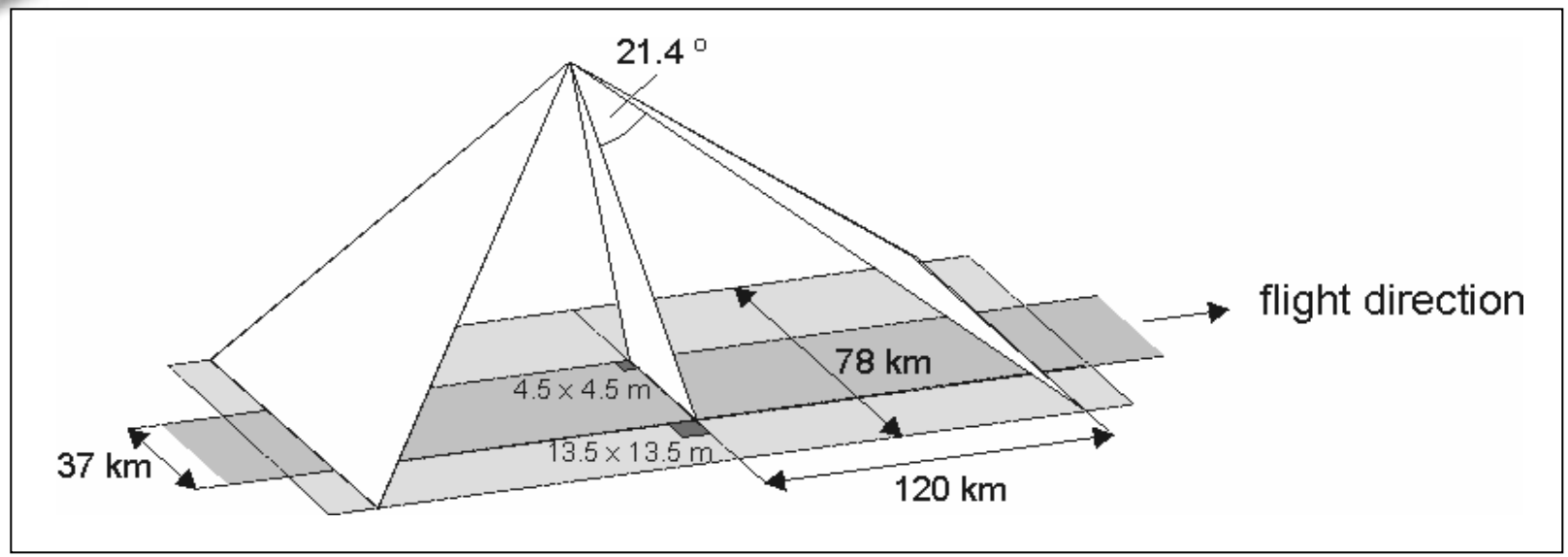
- bundle block adjustment
  - aerial triangulation
  - GPS reduces number of ground control points

Optical satellite data



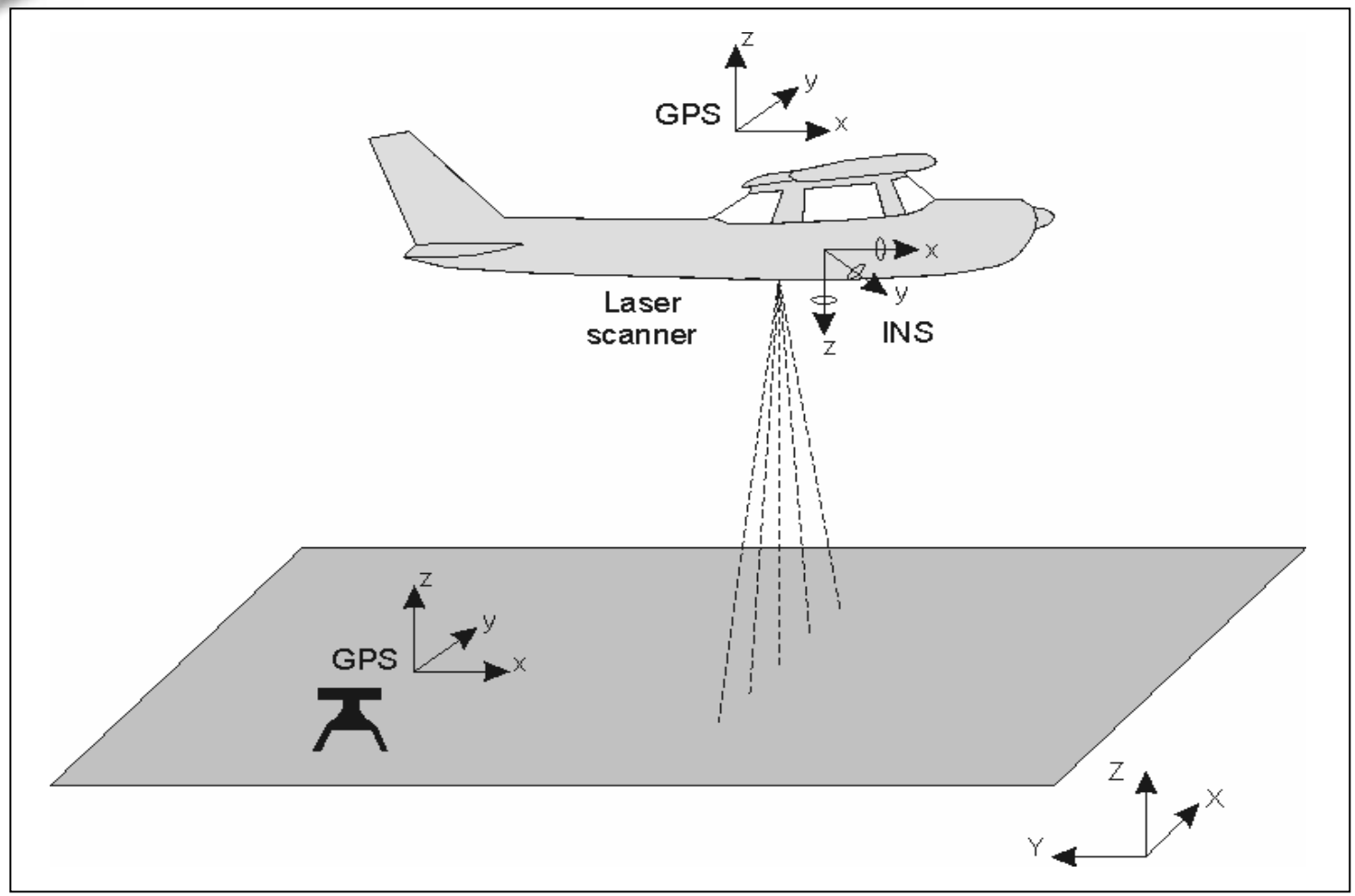
- stereo SPOT Pan images
- two processing approaches
  - geometric model of a CCD line scanner
  - automatic matching techniques

Optical satellite data



- Modular Optoelectronic Multispectral Scanner (MOMS)
- stereo acquisition is along-track direction
  - flown on the MIR station

Laser scanning



Radar techniques

- Radargrammetry
  - same area from two different angles
  - used for long time with airborne systems
  - some potential for RADARSAT data
  - usually requires ground control points

Radar techniques

- Radarclinometry
  - also referred to as shape-from-shading
  - inversion of the radiometric incidence angle correction enables an estimate of local terrain slope
  - filtering of data improves quality

Radar techniques

- SAR interferometry
  - repeat-pass geometry (satellite)
  - covering large areas in short time frame
  - computationally intensive
  - variety of data available

Problem of quality control

- no standard procedure for quality assessment
- no generally accepted specifications

- common procedure: reference DEM
- assumptions
  - reference DEM is correct
  - differences are due to errors in the digital data

  → any distortions in reference DEM remain undetected
- statistically: reference one order better

Quality measures

- lineage (metadata)
  - data history, processing, assumptions etc.
- positional accuracy
  - root mean square (measure of overall accuracy)
  - standard deviation (measure of precision)
- attribute accuracy
- data completeness
  - error of omission (measurable)

Quality measures

- logical consistency
  - structural integrity of the data
  - fidelity of relationships
- semantic accuracy
  - number of features, relationships or attributes which agree with the selected model
- temporal information
  - type of update
  - validity period of the data set

Quality measures

- accuracy of derivatives of height
- slope gradient
  - maximum rate of change of altitude
- slope aspect
  - compass direction of maximum
- profile convexity
  - rate of change of gradient
- plan convexity
  - rate of change of aspect

Quality measures

- ground control points
  - requires 20 interior and eight edge points for determination of root mean square
  - accuracy computed by comparison of linear interpolated DEM elevations with known elevations
  - points well distributed
  - points representative for the terrain
  - order of preference for accepting test points: field control, aerotriangulated points, SPOT elevations, or contour points

Current status

- reference DEM still standard for quality control
- increasing awareness of data quality problem
- more research required
- lack of requirements for DEM from user's side
  - required accuracy level for application
  - useful quality measure to determine usefulness

Questions

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