GGE2012 Advanced Surveying (Course Note)

Contours, DEM

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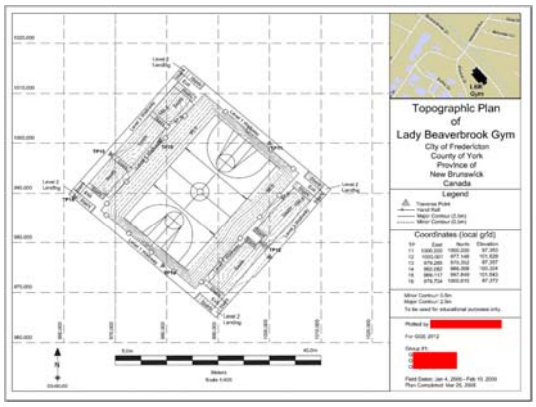
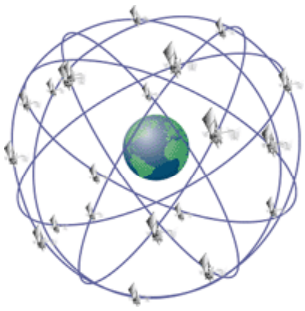




Contours

- Topographical Survey

  - Topography is concerned with local detail in general, including not only relief but also vegetative and human-made features, and even local history and culture. This meaning is less common in America, where topographic maps *with elevation contours* have made "topography" synonymous with relief.

  - Specifically, topography involves the recording of relief or terrain, the three-dimensional quality of the surface, and the identification of specific landforms. This is also known as geomorphometry. In modern usage, this involves generation of elevation data in electronic form. It is often considered to include the graphic representation of the landform on a map by a variety of techniques, including contour lines, Hypsometric tints, and relief shading.

[Wikipedia]

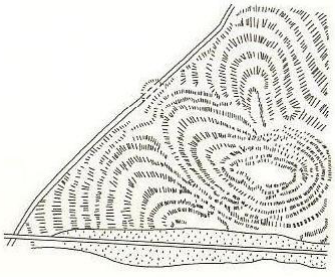
Contours

- Definition

  - In surveying, a contour line is a line connecting points with equal elevation (or height)
  - Similar terms: level set (level contours), isopleth (or isogram, isoline – used for pressure (isobar), for temp. (isotherm))
  - Types: basic contours, index contours, and auxiliary contours (one-half or one-fourth the basic interval)
  - Interval selection: e.g. 1:500 → 0.5, 1:1000 → 1
    : Mapping purposes, Scale, Diversity of Relief
  - Topographic map: a kind of contour map illustrated with the contour lines
  - In more general sense, a contour line is a curve connecting points where the functional value is the same.

Contours

- Representation



1. Hachures

- Older model of representing relief
- A form of shading
- Non-numeric (less useful)
- Austrian topographer Johann Geoge Lehmann in 1799
- Thicker lines in steepness valley
- Thinner lines in smooth terrain

2. Chiaroscuro or Shaded Relief

- Shaded relief, or hill shading
- Drawn with charcoal, airbrush, or other artist's media.
- Replaced by digital elevation model.

Contours

- Representation

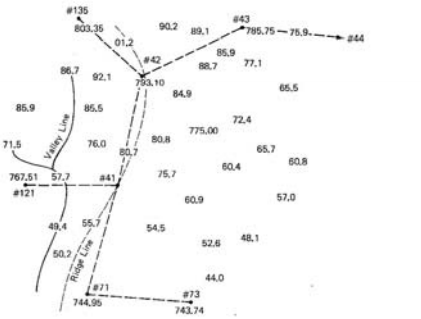


FIGURE 8.6 Plot of survey control, ridge and valley lines, and spot elevations.

3. Spot Elevation

- Numeric representation.
- River, bay, etc.

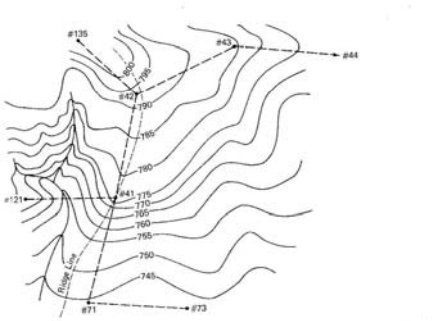


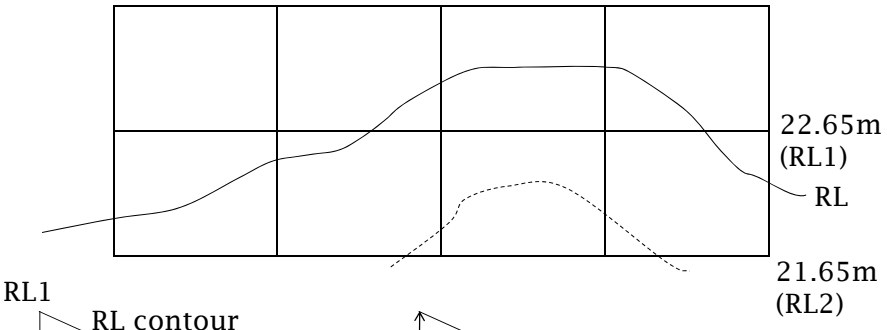
FIGURE 8.7 Contours plotted by interpolating between spot elevations, with additional plotting information given when the locations of ridge and valley lines are known.

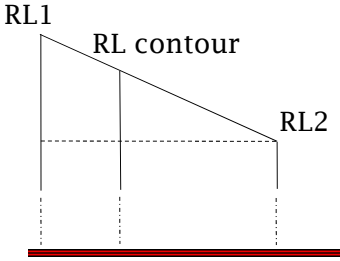
4. Contours

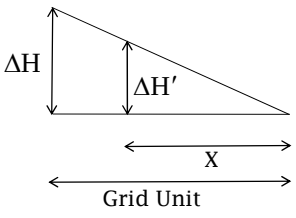
- Interpolation between spot elevations in order to have the same elevation, and connect the lines

Contours

- Linear Interpolation







$$\frac{\Delta H}{\text{Grid Unit}} = \frac{\Delta H'}{X}$$

Contours

- Contour Lines

  :

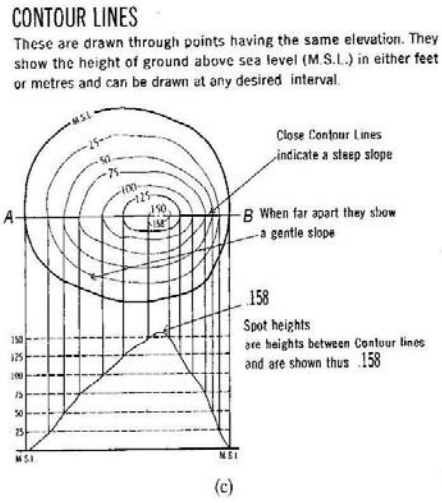
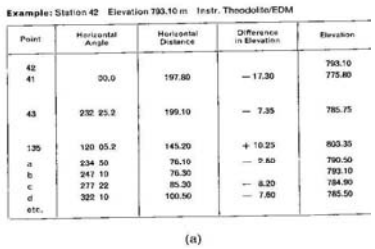


FIGURE 8.8 *(continued)* (c) Contour plan with derived profile (line AB). (Courtesy of Department of Energy, Mines, and Resources, Canada)

Contours

- Break-lines & Break-Areas

  : define significant changes in topography (for example, the tops and bottoms of hills, channels, creeks, etc.) to reflect actual field conditions


Example: Station 42 Elevation 793.10 m Instr. Theodolite/EDM

Point	Horizontal Angle	Horizontal Distance	Difference in Elevation	Elevation
42				793.10
41	00.0	197.80	— 17.30	775.80
43	232 25.2	199.10	— 7.35	785.75
135	120 05.2	145.20	+ 10.25	803.35
a	234 50	76.10	— 9.80	790.50
b	247 10	76.30		793.10
c	277 22	85.30	— 8.20	784.90
d	322 10	100.50	— 7.60	785.50
etc.				

(a)

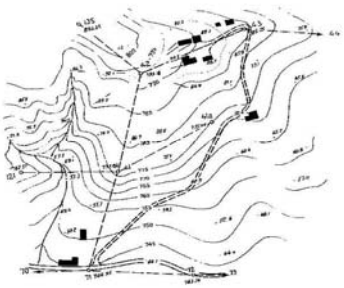


FIGURE 8.8 (a) Survey field notes. (b) Plan plotted from notes shown in Figures 8.6, 8.7, and 8.8(a). (Courtesy of Leica Co. Ltd.)

(b)

Contours

- Characteristics
  - larger gradient means → variation is strong; steep
  - are continuous and form closed loops.
  - Because contours join points of equal elevation, no branching allowed (with the same elevation).
  - Normally with the constant interval.
  - Contours are not shown going through buildings
  - Contours crossing human-made horizontal surface (road, railroads) will be straight parallel lines as they cross the facility
  - can be traced on a DEM (three dimensional, digital elevation model from stereo-model plots) or interpolated elevation values using a series or network of observation.

Contours

- Contour Lines

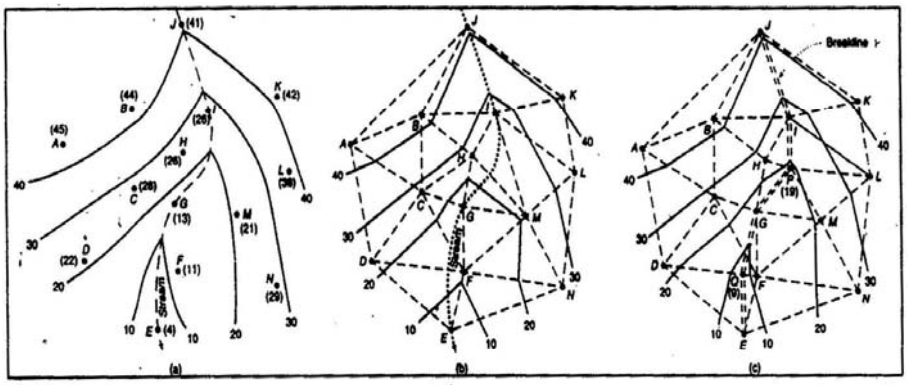
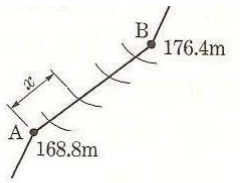


Figure 16-6. (a) Contours compiled by hand from controlling-points A through N. (b) TIN model (shown with dashed lines) constructed from data of Figure (a), and contours derived from TIN model (shown with solid lines). Stream is shown with dotted line. Note striking differences between the 10- and 20-m contours of Figures (a) and (b). (c) TIN model (shown with dashed lines) constructed from data of Figure (a) but with the addition of two points, P and Q, and the designation of lines EQ, QG, GP, PI, and LJ as breaklines. Contours shown with solid lines were derived from this TIN model. Note the agreement of these contours with those of Figure (a).

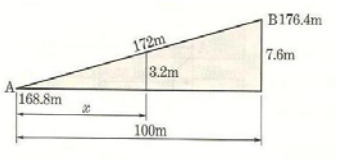
Contours

◆ **Example 1)**

Inclination between A and B is invariant and the horizontal distance from A to B is 100m. We are going to include contour lines in every 2m. In this case, what is the horizontal distance from A on the point of the height of 172m?



Ans.)



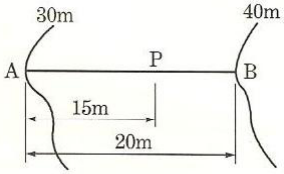
$$100 : 7.6 = x : 3.2$$

$$\rightarrow x = 42.1m$$

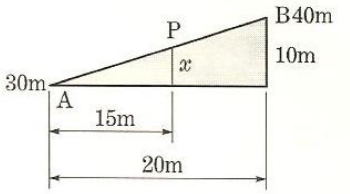
Contours

◆ **Example 2)**

We would like to make a contour line for arbitrary point P. When the measured horizontal distance from A to P is 15m and the horizontal distance from A to B is 20m, what is the elevation of the point P?



Ans.)



$$20 : 10 = 15 : x$$

$$\rightarrow x = 7.5m$$

$$\rightarrow H_p = H_A + x = 30 + 7.5 = 37.5m$$

TIN

- TIN (triangulated irregular network)

  : surface of contiguous, non-overlapping triangles
  : each triangle is made from a set of points called mass points
  : based on Delaunay Triangulation (the method that a circle drawn through the three nodes of a triangle contain no other nodes)
  : alternative way of GRID (linear interpolation between points) approach
  : more precise way of description of the surface at different level of resolution

DEM (Digital Elevation Model)

- Definition

  - A digital elevation model is a digital representation of continuous surface of the ground by a large number of selected points with known X,Y,Z in a specified coordinate system.
  - Also, called DTM (digital terrain model).

- Characteristics

  - can be represented as a raster (a grid of squares) or as a TIN (triangular irregular network).
  - commonly used for remote sensing area, land surveying or GIS, or digitally produced relief maps.
  - most precise way is based on the modern "RADARSAT-1" (interferometric synthetic aperture radar) → different data interpolation techniques.

DEM (Digital Elevation Model)

- An Example
  - Digital representation of continuous surface of the ground

DEM (Digital Elevation Model)

- Limitation or Key factor for DEM
  - Terrain roughness
  - Sample density (elevation data collection methodology)
  - grid resolution or pixel size
  - interpolation algorithm
  - vertical resolution
  - terrain analysis algorithm
- Usage
  - Extracting terrain parameters,
  - modeling water flow or mass movements
  - creation of relief maps
  - rendering of 3D visualization
  - creation of physical models
  - rectification of aerial photography or satellite imagery
  - reduction of gravity measurements (physical geodesy)
  - terrain analysis in geomorphology or physical geodesy

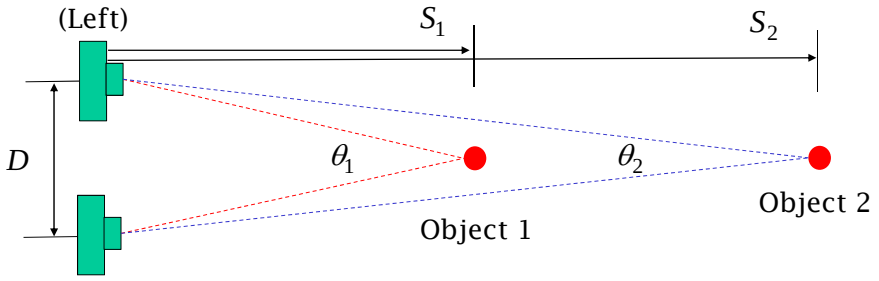
DEM (Digital Elevation Model)

- Fundamentals idea in making 3D depth (perspective)

Right Photo

Left Photo

Note) When the two images are overlapped, the geometry will be completely changed. Think it in reverse way!



(cf. Same for human eyes)

Q1) What is known values? D, θ_1, θ_2

& What is unknown value? S_1, S_2

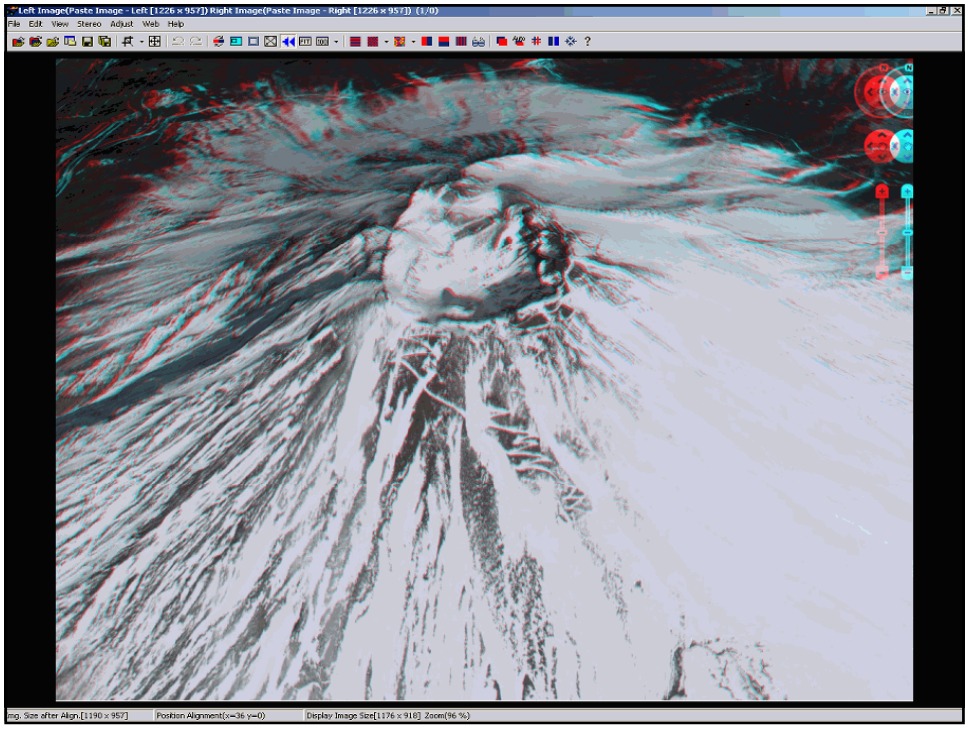
DEM (Digital Elevation Model)

- Is this fundamentals idea in making DEM different?

  History: In 1838, a British scientist, Charles Wheatstone invented stereoscopic pictures and viewing devices. DEM→ a different form.

- Example- Google Stereo Image

Left Right



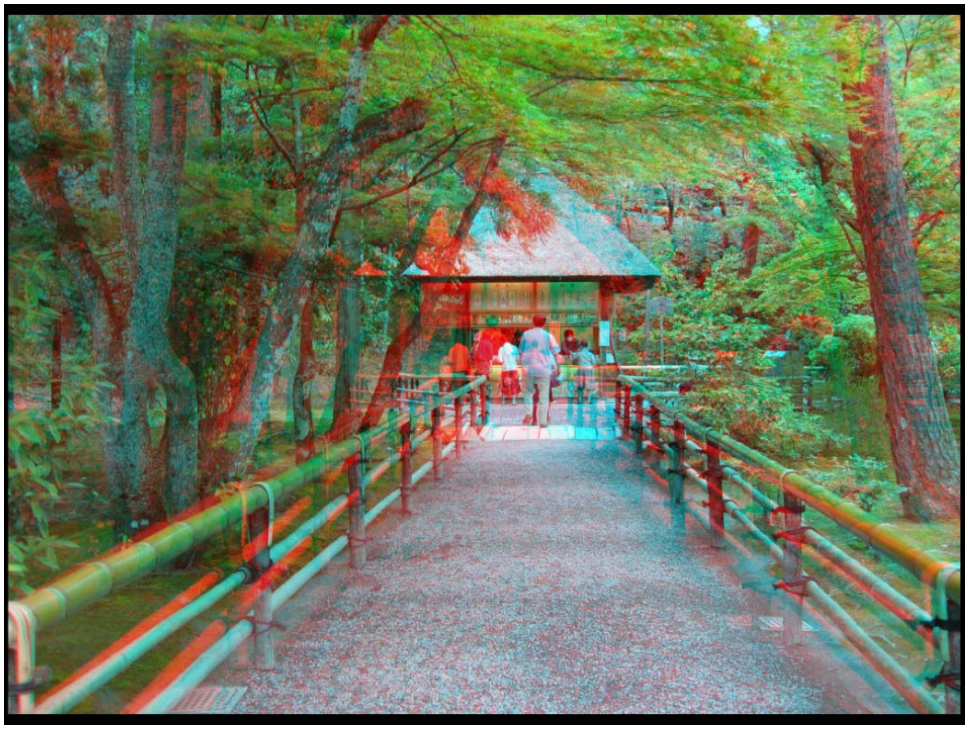
DEM (Digital Elevation Model)

- How about images taken from two digital cameras?

Left Right

Possible Advanced Application (in Reverse Way) - In Geomatics Engineering point of view? http://www.youtube.com/watch?v=W6GHFb16mik

(Courtesy from Masuji Suto)




Synchronization
(~1/10,000 sec)
with custom designed
sync and 3D devices
(12MP, and 790p 30fps)
During GGE2013 GPS Field Survey in 2010

DEM (Digital Elevation Model)

- Recent updates for 3D application (could be a Geomatics area, and might have some great ideas with more advance way than this???)
- http://www.youtube.com/watch?v=6BFKC-NKRFw (accessed on Feb. 28,.2011)

◆ Canada's 3D DEM

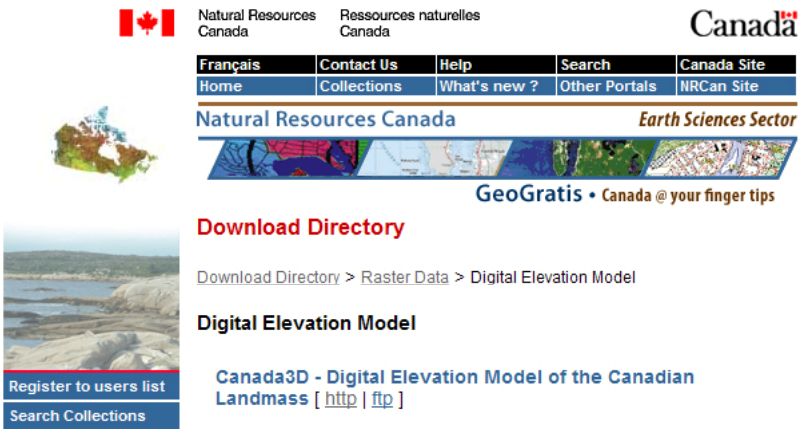
- Canada3D – Digital Elevation Model of the Canadian Landmass.
- Provided by NRCan's Earth Science Sector.
- Distribute in ESRI Arc/Info ASCII Grid files (widely supported format) in registered user account.
- Available at both horizontal grid spacing of 30 and 300 arc-seconds.
- The elevation values are based on CVGD28 (Canadian Vertical Geodetic Datum of 1928) in units of metres.
- The link is the following:

http://www.geogratis.ca/

DEM (Digital Elevation Model)

◆ Canada's 3D DEM

- Downloading Directory



DEM (Digital Elevation Model)

- An example (Seoul)