Chapter 3 Data Acquisition in an Urban Environment

- One fundamental issue : cost of data

  5-10 times of HW, SW, org ware, staff training, maintenance

- Another issue : different kinds of data

  alphanumeric – character strings, numbers

  multimedia – signals, images, audiovisuals

3.1 Data from administrative routines

- Census data

  nation-wise, periodical (usually 10 yrs), demography included

- Data from administrative files & forms

  all files storing data concerning public services can be used

  ex. School management

  name of school, address, phone number, number of classes & pupils

- Registers

  files kept & updated daily from their inception, nation-wide or local

  ex. population w/ address, buildings, land ..

- Polls

  data from polls

  ex. number of people going to certain facility, level of satisfaction

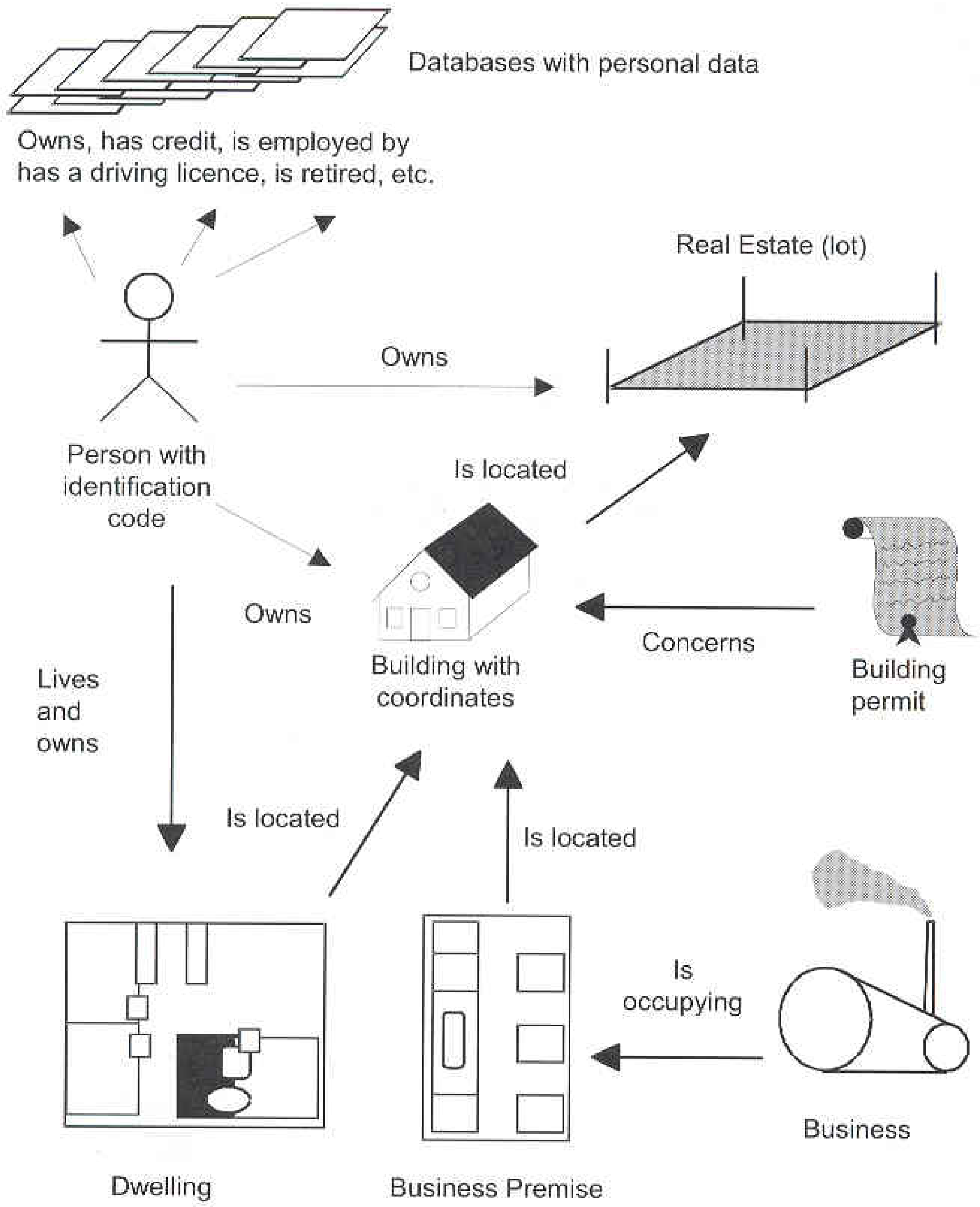


Figure 3.1 The basic elements of nation-wide databases and their internal and external links in Finland.
According to Lahti 1994.

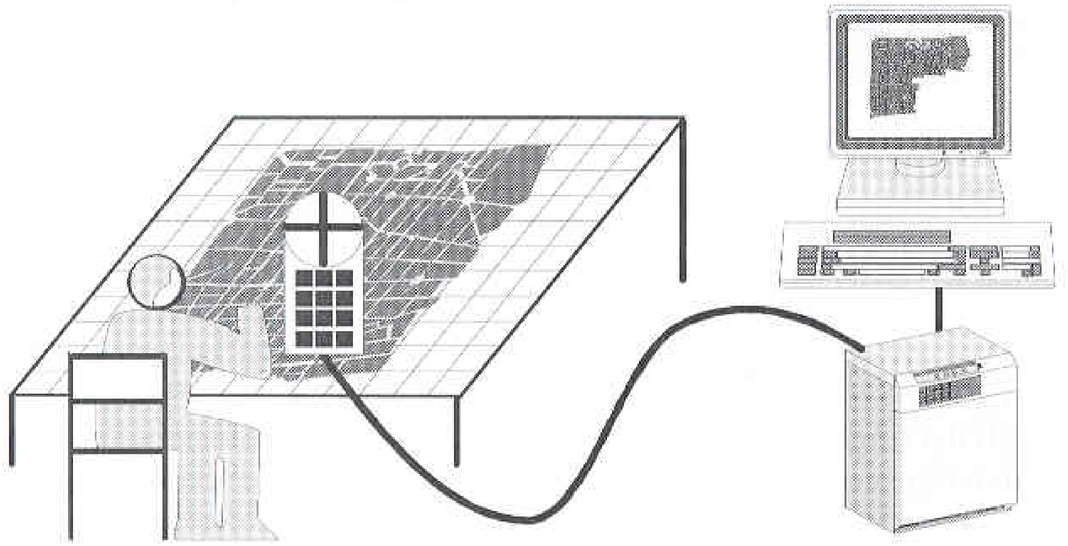


Figure 3.2 Principle of a digitising tablet.

3.2 Map digitizing & scanning

- Common way to capture cartographic info

- Process : capture feature coords -> select control points -> transformation
  usually affine / pseudo affine transformation is used

$X=ax+by+c \quad Y=a'x+b'y\_c'$

$X=ax+by+cxy+d \qquad Y=a'x+b'y+c'xy+d'$

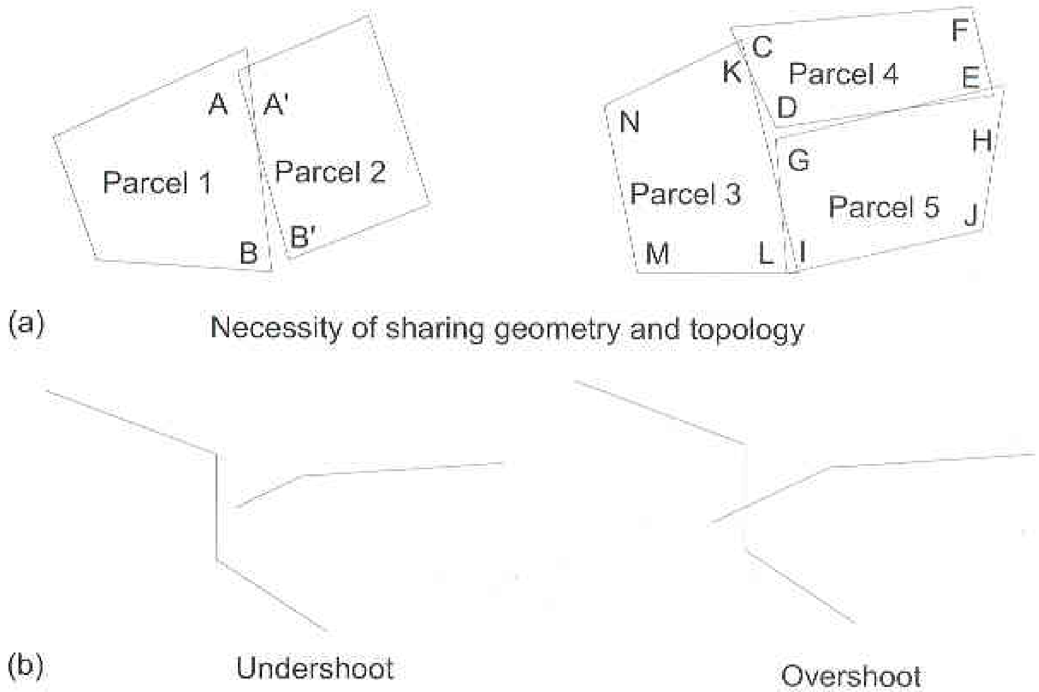


Figure 3.3 Some commonly occurring problems when digitising. (a) Necessity of sharing geometry and topology. (b) Undershoot and overshoot.

- Problems of digitizing

necessity of sharing geometry & topology

* points & lines w/o connections -> spaghetti model

undershoot & overshoot

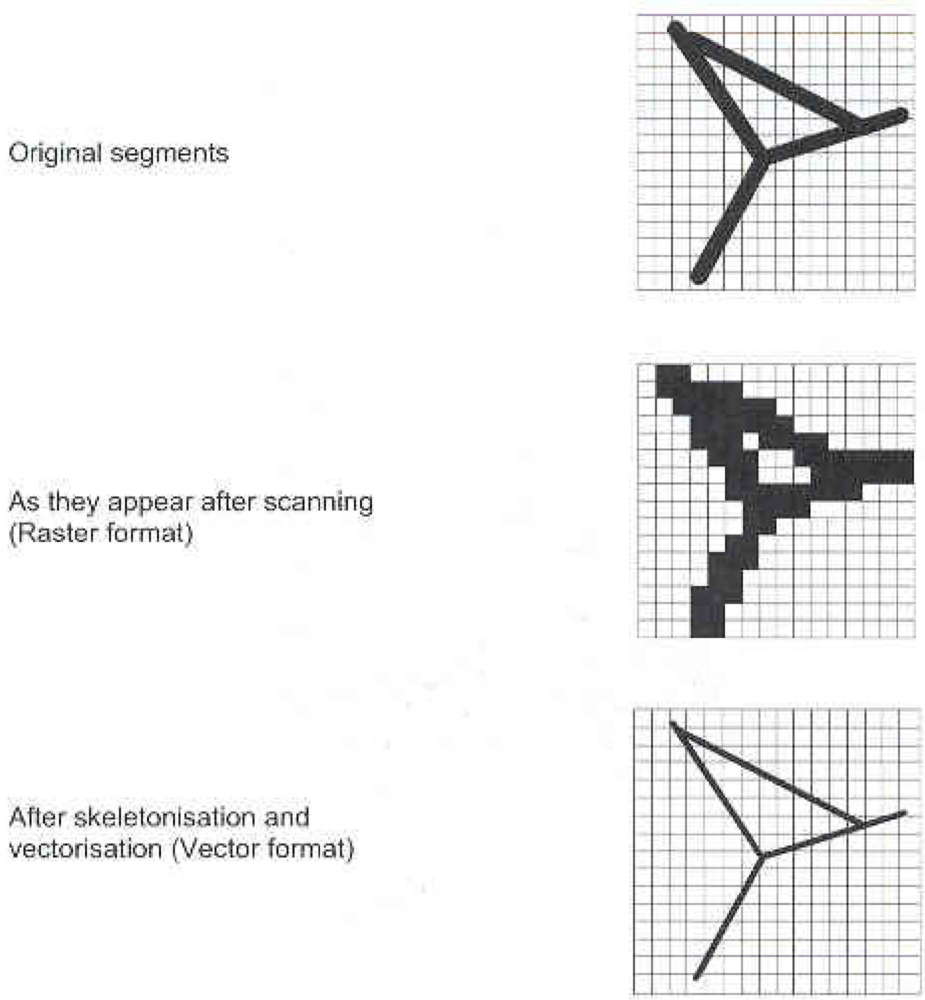


Figure 3.4 From raster to vectors.

- Scanning

  capture B/W imagery w/o distinction -> vectorization -> regroup relevant segments to represent features

- Vectorisation

  scanned lines of width -> skeletonization

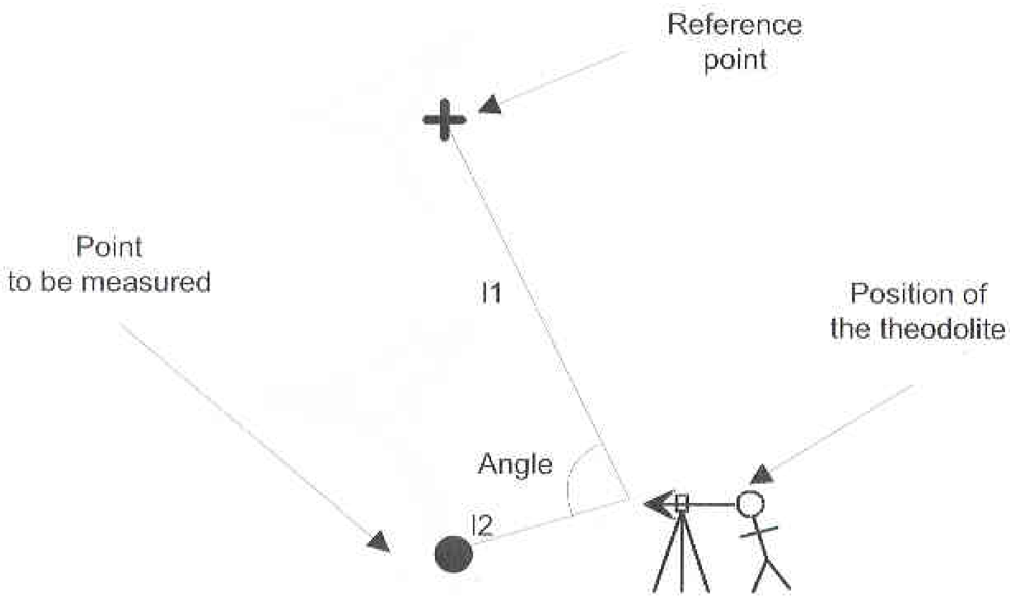


Figure 3.5 Principle of point measuring by means of a theodolite.

- Terrestrial surveying

  traditional method used chains

  now-a-days : theodolites & tacheometers

    needed reference points to start from coordinates

    geodetic reference points constitute a special network

Figure 3.6 Example of an aerial photo.
Source: http://www.aerial-photos.com/vertical.htm. Photograph by CAP-Orlando, FL, USA. Published with permission.

3.3 Aerial photographs & satellite images

- Aerial photographs : a typical way to capture spatial data
  first aerial photos : during World War I w/ BW
  these days people value seamless orthophotos mosaic

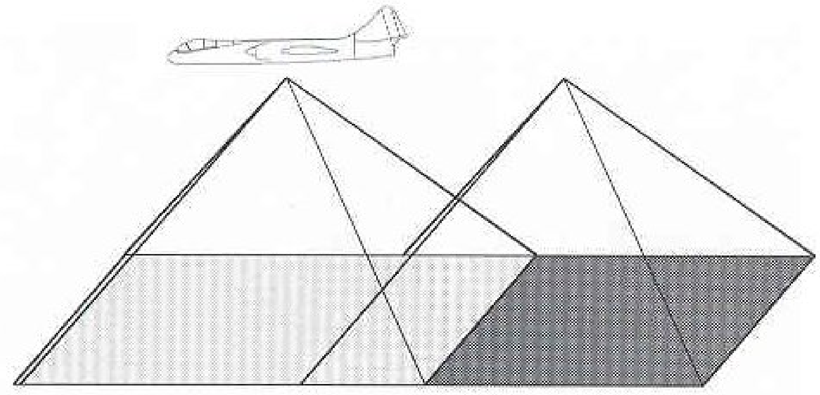


Figure 3.7 Aircraft taking photographs.

- Aerial photographs

  usual flying height : 2,000 to 10,000 feet

  typical scale : 1:1,000 to 1:50,000 (Scale=Focal Len/Flying Height)

  photo size : 23cm * 23cm

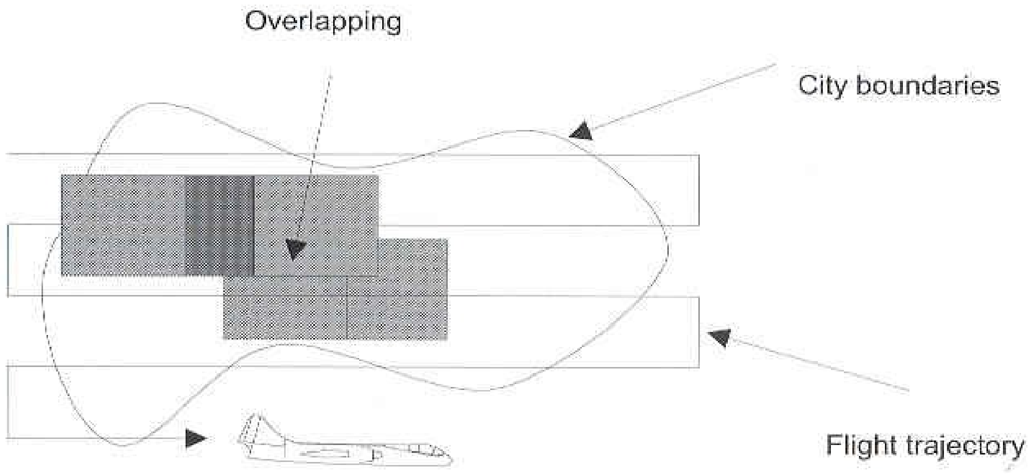


Figure 3.8 The flight trajectory, the swath and overlaps.

- Flight plan needs to define swath & overlaps

    common overlap : end lap 60%, side lap 25%

Figure 3.9 Example of aerial photo template for the City of Bologna.
Source: http://sit.comune.bologna.it/foto/foto97.htm. Published with permission.

- Flight plan needs to consider the purpose of photographing

  geomorphology analysis : winter is preferred

  tree analysis : summer is preferred

  * example of air photo template (figure)

- Scale ?   urban : 1:10,000~1:20,000   rural : 1:20,000~1:50,000

Figure 3.10 Building leaning.

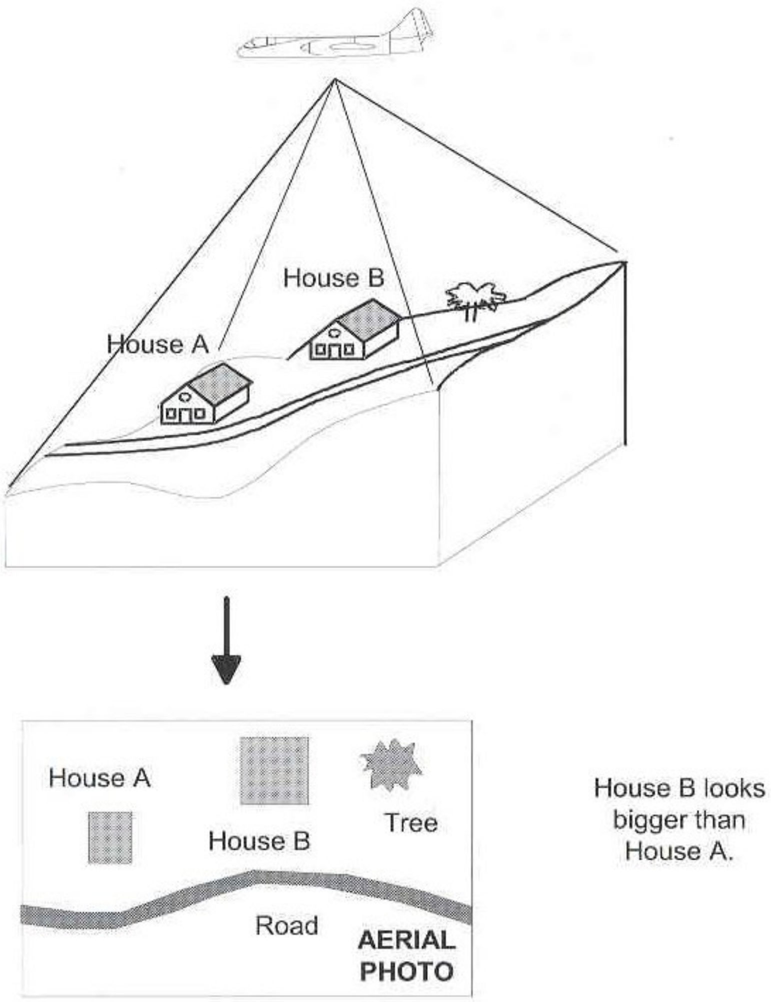


Figure 3.11 Similar geographical objects appear to be different sizes.

- Photogrammetric compilation requires comprehensive analysis

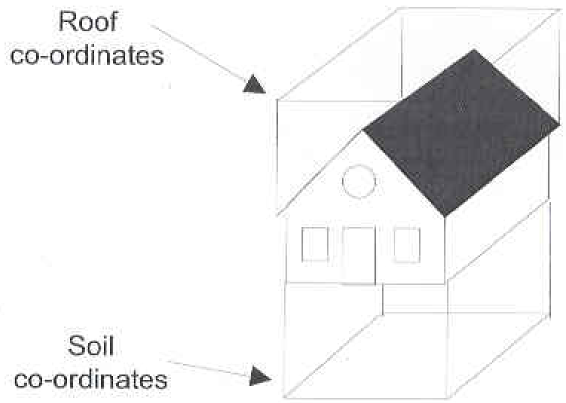


Figure 3.12 Differences between surface and roof co-ordinates.

- Another problem : diff between surface & roof coords

<u>Ortho photos</u>

- people prefer to work w/ seamless photos looks like a map
- general process
  : air photo -> ortho rectification -> mosaicking
- many techniques are employed
  : camera modeling, collinearity condition, resampling, geo-referencing, affine/polynomial transformation, rubber-sheeting, colour balancing

Figure 3.13 Example of a satellite image.

- Satellite images

    not so much used for low resolution -> need several decimeters

    ex. LANDSAT, SPOT, EURIMAGE, IKONOS

    some cases useful : landuse planning, green space planning ..

    complementary to aerial photos, low price compare to aerial photos

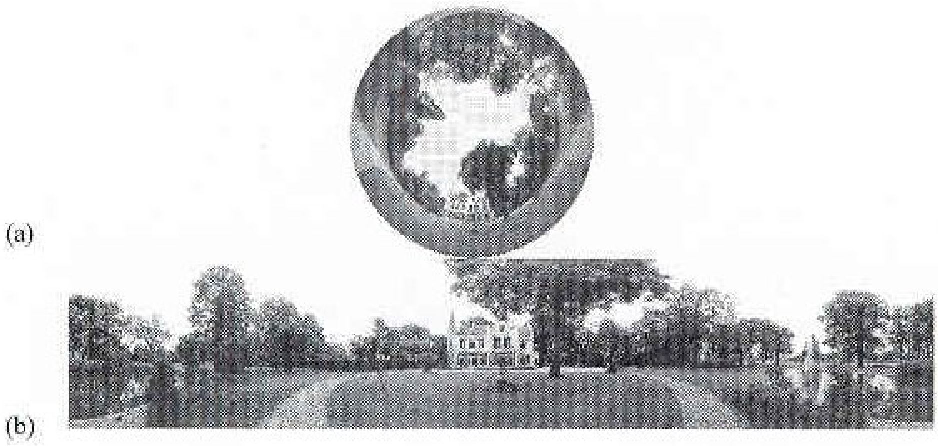


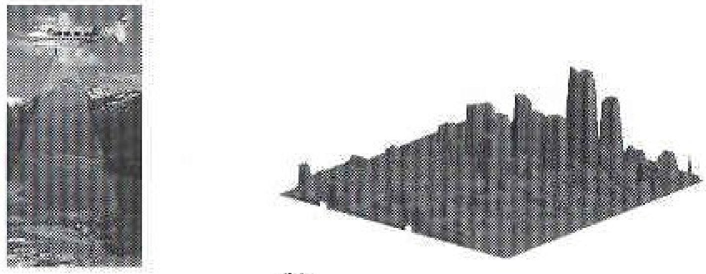
Figure 3.14 Example of a fish-eye photo and its transformation. (a) Cycloramas are digital panoramic images with a horizontal field of view of 360° and a vertical field of view from 30° below up to 60° above the horizon. (b) CycloMedia is the brand name of the Frank Data products on the market.

- Vehicle photogrammetric system

uses car-mounted camera taking fish-eye photos

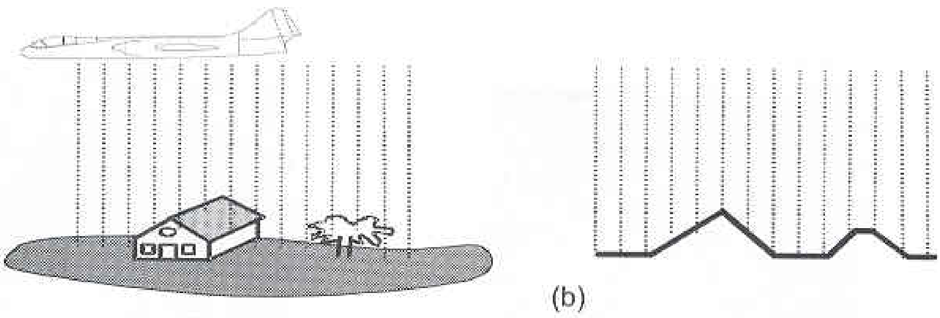
ex. Frank system (figure)

real-time acquisition, stereo-compilation is possible



(a) (b)

Figure 3.15 The principles of data acquisition with an airborne laser. (a) Example of an aircraft equipped with a range laser (Source: http://www.optech.on.ca/imagegall.html. (b) Example of terrain modelling in Denver, Colorado Courtesy of http://www.eaglescan.com/products.html. Used with kind permission of Eaglescan.



(a) (b)

Figure 3.16 Using the airborne laser. (a) Regular beams are sent. (b) Result giving the profile.

3.4 Range finders & lasers

- Basic system components : laser assembly, GPS, IMU
- Two laser types : pulse & continuous wave (CW)   *pulse preferred
- Flying speed : 200 ~ 250km/h   Flying height : 300~3,000 meter
- Scan angle : up to 20degree   Pulse rate : 2,000~25,000Hz
- Accuracy : 0.1% of flight height(vertical), could be worse in horizontal

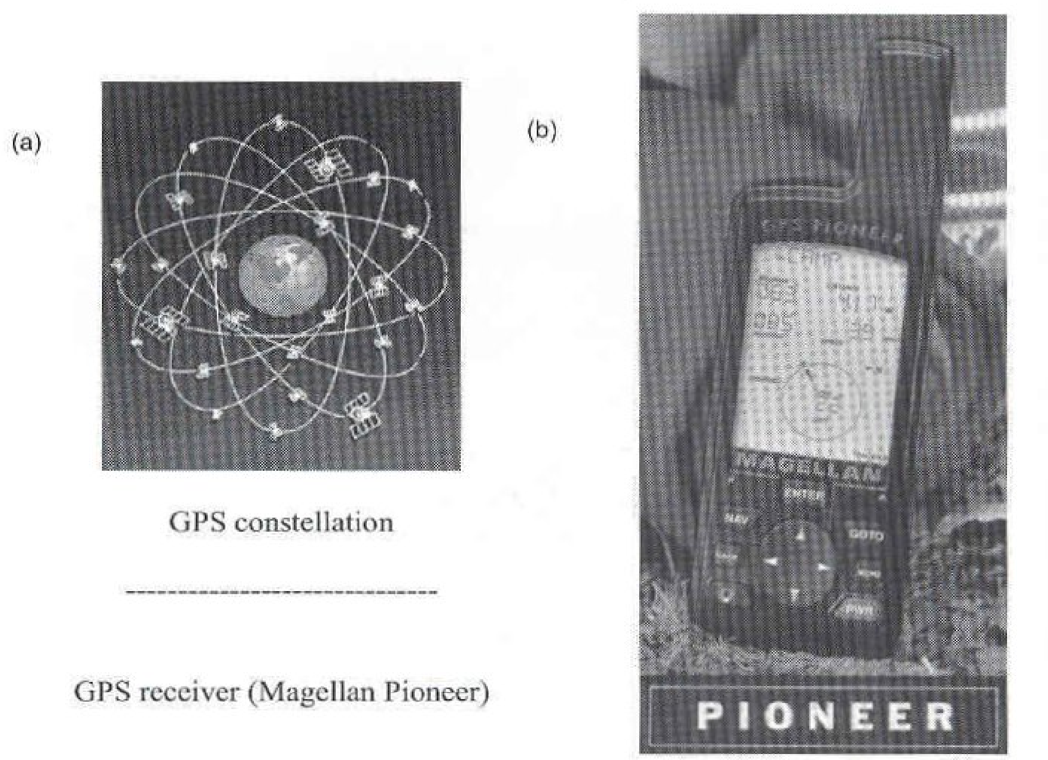


Figure 3.17 GPS constellation of satellites over the earth and example of a GPS receiver. (a) GPS constellation (Source: http://www.colorado.edu/geography/gcraft/notes/gps/gif/orbits.gif). (b) Example of a Magellan GPS receiver.
Source: http://www.nvlt.com/pioneer.htm) Used with kind permission of Magellan.

3.5 GPS (Global Positioning System)

- Major functions

  : calculate user's position on ground by satellite constellation

- GPS Satellite

  : use Hertzian waves, 20,200km orbit, 12hr rotation period

  4 automic clocks (emit fundamental frequency 1023Mhz signal)

  7 yrs life cycle, 24 satellite constellation

- Accuracy ranges

  : 20~100meters (absolute positioning)

  10m~10cm (relative positioning including differential tech)

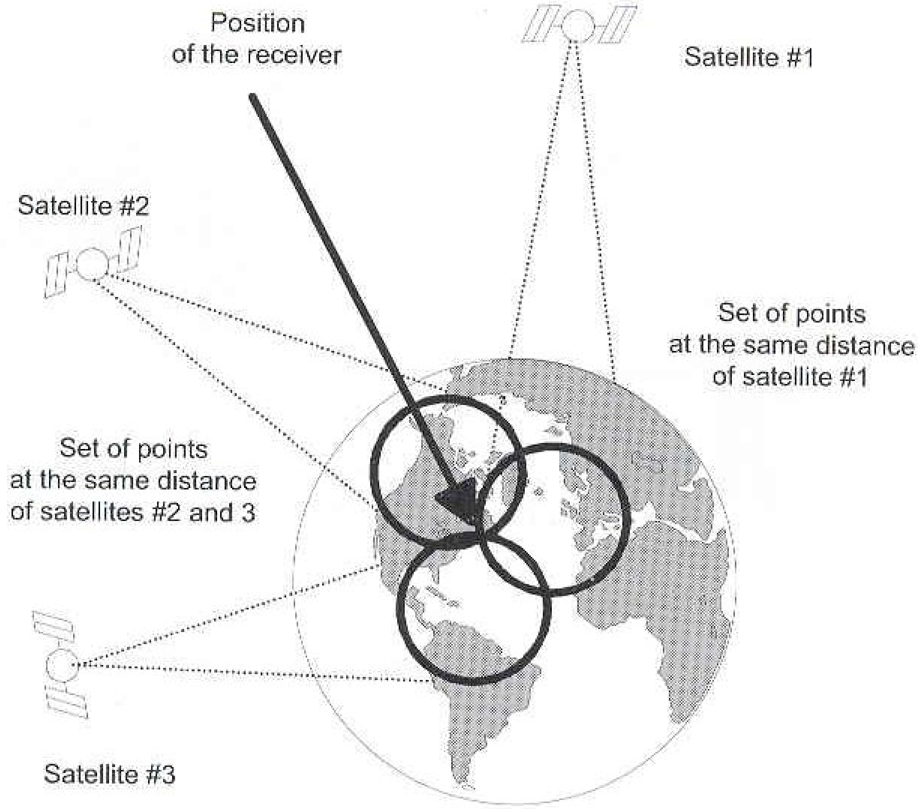


Figure 3.18 Computing location from three GPS satellites.

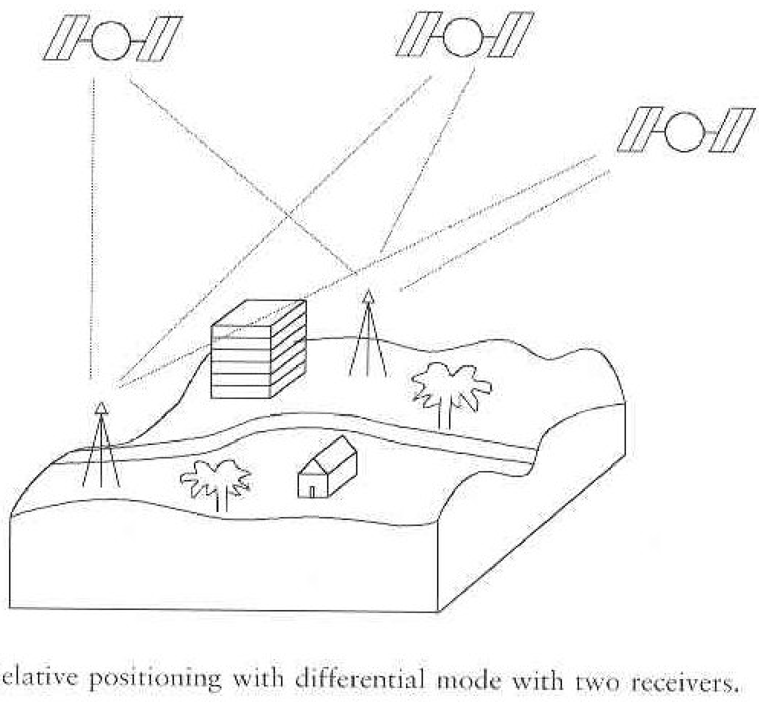


Figure 3.19 Relative positioning with differential mode with two receivers.

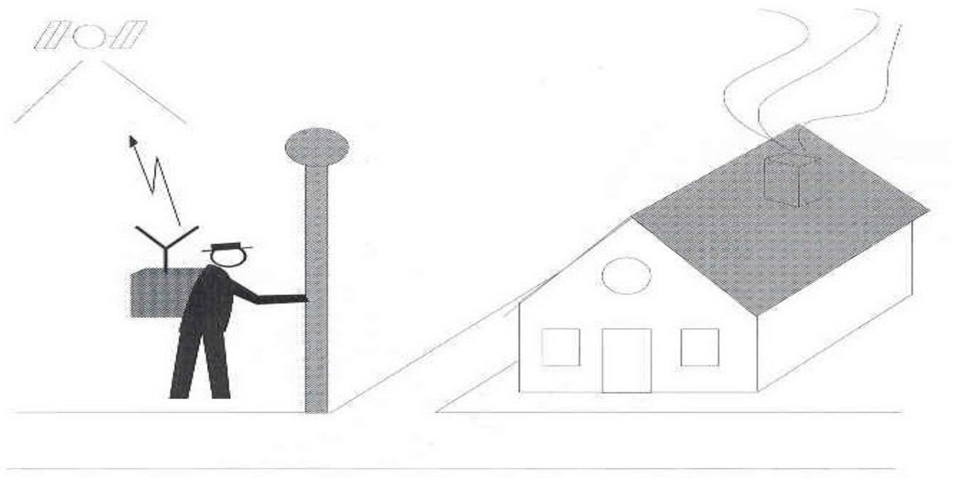


Figure 3.20 GPS field data collection.

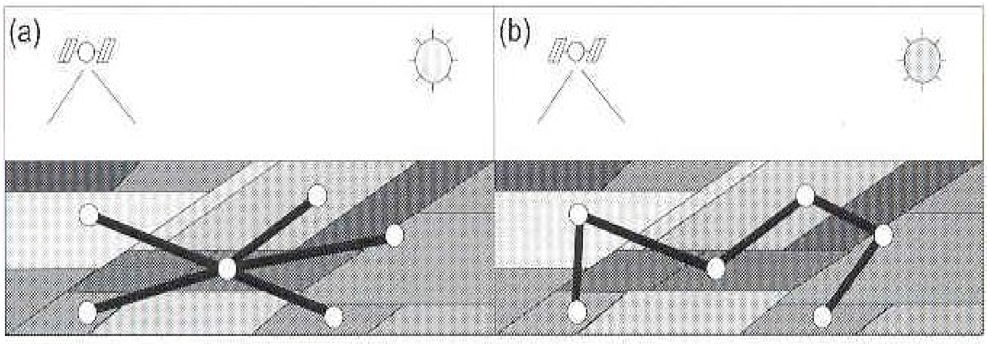


Figure 3.21 Different methods for capturing point co-ordinates with GPS. (a) From a central point. (b) Along a route.

- Two methods capturing point coords

use a reference point for differential mode,

then, a. capture other points' coords

b. mobile compilation using position & speed measurement

-> mobile GPS : rescue vehicle, car navigation ..

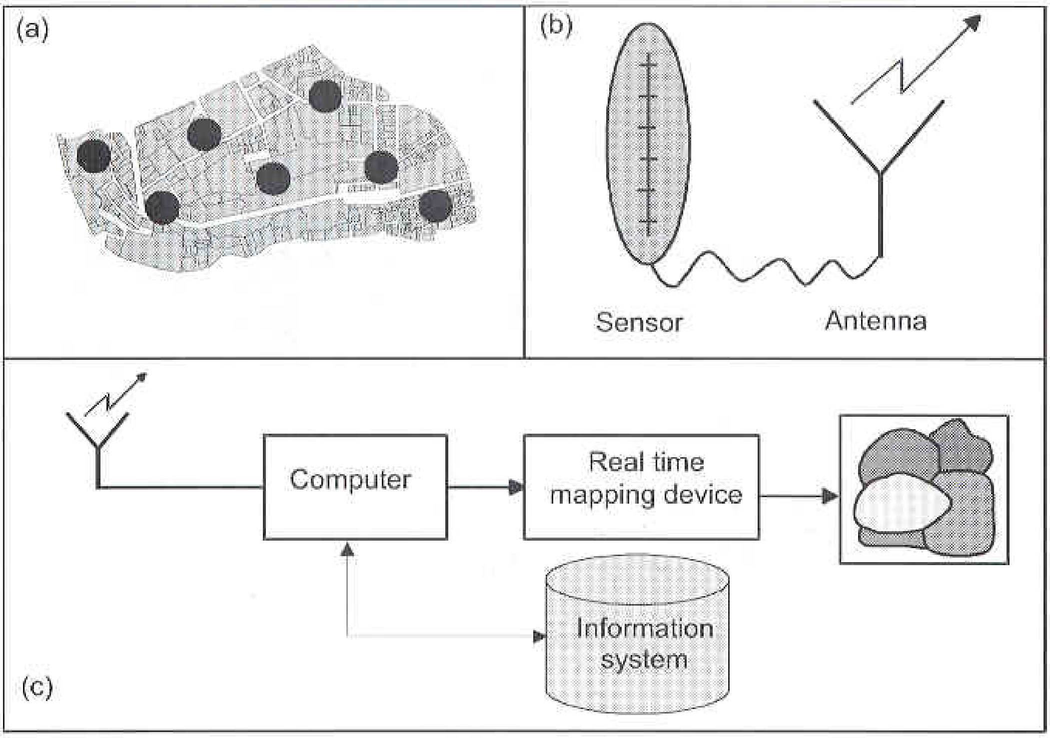


Figure 3.22 General architecture of an information system for air pollution control. (a) Location of sensors throughout the city. (b) Each sensor regularly sends measurements by means of a cellular phone to the control centre. (c) The control and monitoring centre receives phone calls from the sensors and produces a map of pollution which is regularly updated in real time.

3.6 Sensors

- more and more data concerning urban environment are captured daily

  ex. Temperature, noise level, air pollution

- various sensors across a city capture data and send to control station

  -> collect, analyze, store

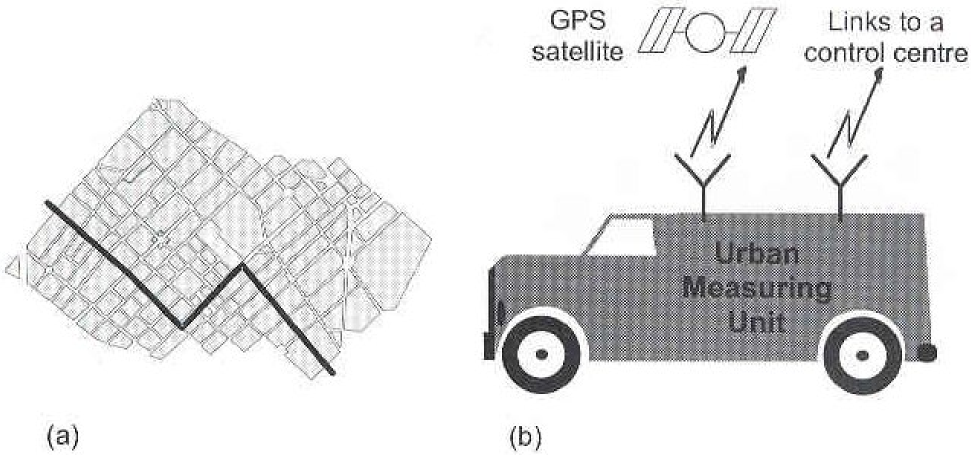


Figure 3.23 Principle of a vehicle equipped with sensors connected to GPS in order to make real-time measurements. (a) Path of the vehicle in real time. (b) Vehicle showing connection to GPS and to a control centre.

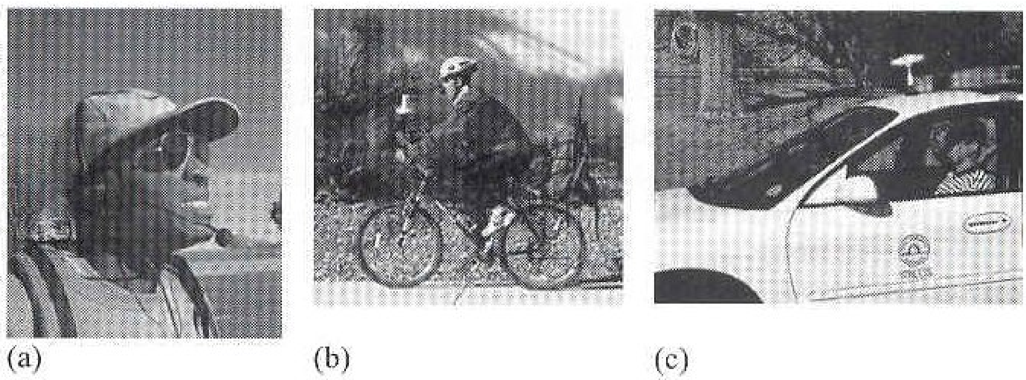


Figure 3.24 Example of voice-based technology in geographic data capture. (a) Headset microphone. (b) Biking unit. (c) Car unit.
Source: http://www.stantec.com/datria). Used with kind permission of Stantec Global Technologies Ltd.

3.7 Voice technology & spatial data acquisition

- voice tech can help a lot in geo data acquisition
  -> transmit info via voice device

- possible application areas
  : road maintenance & inventory, building inspection
    waste water & neighborhood appearance, abandoned cars & fines ..

    ex. Datria, Stantec : company marking such devices

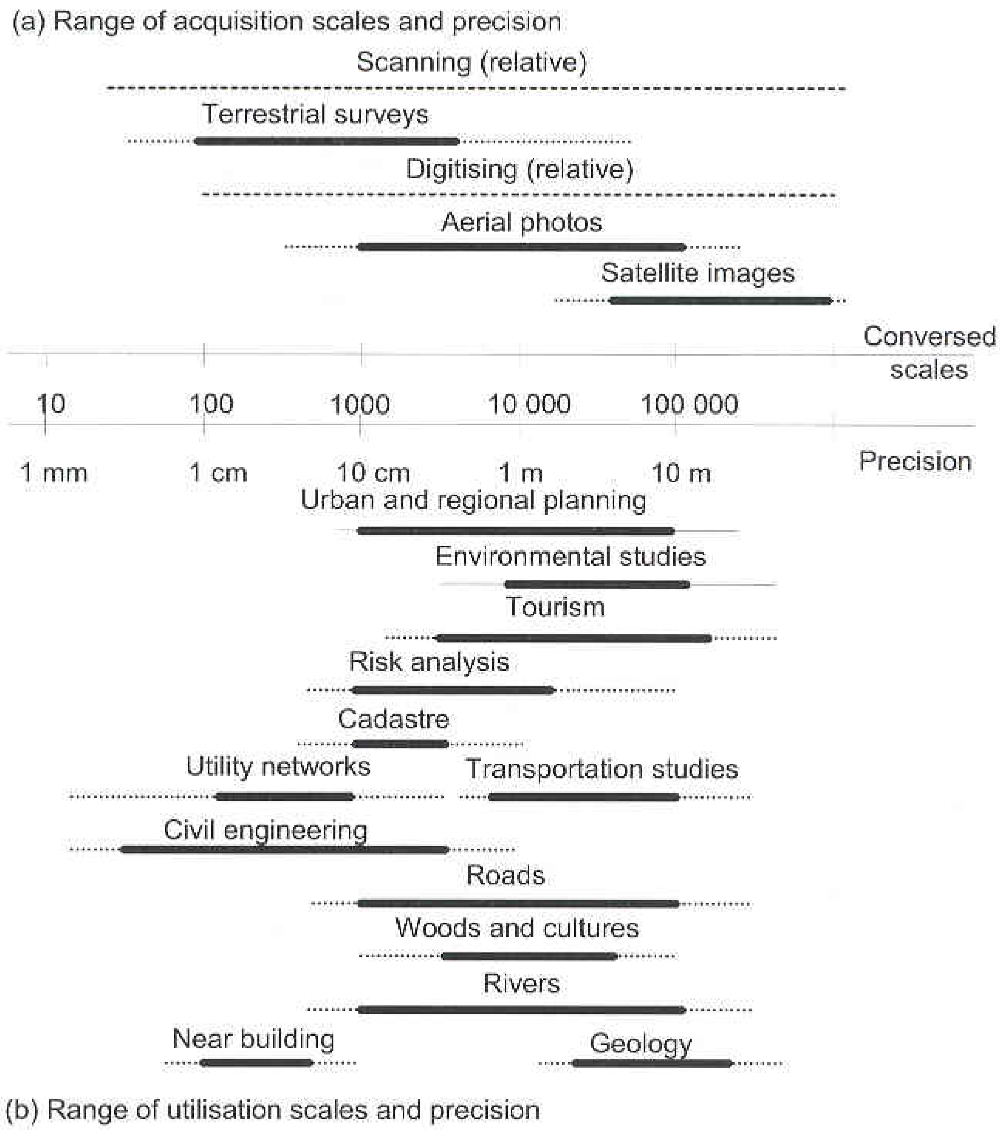


Figure 3.25 Scale, data acquisition and main utilisation. (a) Range of acquisition versus scale. (b) Range of utilisation versus scale.

3.8 Remarks on quality, scales, resolutions & applications

- one issue : selecting right acquisition mode
  -> need to consider many factors, such as quality, scale, resolution, application, cost, accuracy..