Airborne Laser Scanning Range Resolution

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Range Resolution

- Resolution: Precision with which the measurement is made
- Degree of Range Resolution dependent on:
  - width of transmitted laser pulse
  - types & sizes of targeted surface
  - efficiency of the receiver & indicator equipment

- Emits laser pulse which travels to the surface & reflected radiation returns to laser sensor
- Measures time-of-flight of short flash of laser radiation
- $\Delta R = c\,(\Delta t/2)$

ΔR= range resolution (cm)
c =speed of light 300,000 km/s
Δt= resolution of time measurement

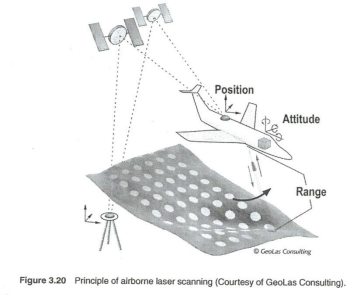


Figure 3.20 Principle of airborne laser scanning (Courtesy of GeoLas Consulting).

Pulse Laser Resolution

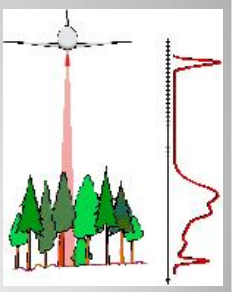
- Increase in the resolution of time measurement (Δt) increases the range resolution (ΔR)
- Higher resolution (ΔR) value means a decrease in resolution precision

Pulse Laser Resolution

Continuous Wave Laser Resolution

- The CW samples return signals very rapidly & stores the entire waveform
- i.e. Forest canopy; CW laser emits a pulse & returns multiple reflections of tree canopy, intermediate, understory , & ground surface vegetation
- $\Delta R = (1/4\Pi)(c/f)\,\Delta\ell$

ΔR=range resolution
c= speed of light
f=frequency (Hz)
$\Delta\ell$=phase resolution (for CW lasers) (rad)



References

- Lillesand, T. M., Kiefer, R. W., and Chipman, J. W. 2004. *Remote Sensing and Image Interpretation*, **5th edition**. John Wiley & Sons.
- Li, Z., Zhu, Q, and Gold, C. 2004. *Digital Terrain Modeling: Principles and Methodology*. CRC Press.
- GeoLas Consulting http://www.geolas.com/Pages/laser.html

Questions

- How do you calculate the range resolution of a pulse laser?

Answer: $\Delta R = c(\Delta t/2)$

ΔR= Range Resolution

C= speed of light

Δt= resolution of time measurement

- How do you calculate the range resolution of a continuous wave (CW) laser

Answer: $\Delta R = (1/4\Pi)(c/f)\,\Delta\ell$

ΔR=range resolution

c= speed of light

f=frequency (Hz)

$\Delta\ell$=phase resolution (for CW lasers) (rad)

- What are the resolution advantages of the CW laser?

Answer: There are more laser returns which yield a finer detailed resolution; i.e. in a forest canopy the CW laser can distinguish the top canopy as well as the intermediate and understory canopy.

- What is the wavelength range of the pulse laser?

Answer: 10-40 nanometers; just above the visual range of the electromagnetic spectrum