TD1 – LIDAR

1. Beam divergence, spot size and resolution

a) An automotive Radar emitting at a frequency of 77 GHz has an exit aperture of diameter 20cm. Assuming a Gaussian beam and based on the beam divergence, calculate the spot size at a distance of 100m.

b) An automotive Lidar at a wavelength of 1550nm has an exit aperture diameter of 5mm. With the same assumptions calculate the spot size at a distance of 100m.

c) Comment on the expected spatial resolution of the two systems

2. Distance ambiguity and maximum range

An airborne topographic Lidar operates at a pulse repetition rate of 100kHz. What is the maximum height at which the Lidar should be flown based on distance ambiguity considerations.

3. Sampling grid

A topographic Lidar placed on the roof of a car covers a 360° horizontal field thanks to a mirror rotating at 10Hz. If the Lidar pulse repetition rate is 50kHz calculate:

a) the angular sampling point separation

b) the spatial sampling separation at a distance of 100m

Compare with the result for question 1 and comment.

4. Data set size

The specifications for a new vehicle mounted Lidar system require:

- 100m minimum range
- range resolution 35cm
- 360° azimuthal coverage (horizontal)
- 20° declination coverage (vertical)
- 0.2° angular resolution
- 20 frames/s (video rate acquisition)

a) Calculate the number of samples required per second

b) The maximum repetition rate attainable at 100m with existing light sources and detectors is around 1.5MHz. Suggest ways of overcoming this limitation in the new lidar system.

c) Check that this repetition rate is compatible with the minimum range in terms of range ambiguity

d) Estimate the number of bytes per sample and the data storage capacity for 1hr of data acquisition (angular coordinates and range for each point)

e) This system is now used to perform a topographic mapping of a town by combining the Lidar data with high resolution GPS positioning equipment also available in the vehicle. If the position of each Lidar data point is to be recorded in GPS coordinates to the required resolution, estimate the new data storage capacity required.