Exercises for Chapter 4

Exercise 1: Side-Looking (Real Aperture) Radar

Explain the geometry associated with a Side-Looking Radar (SLR) and visualize the change of the pixel-size across the swath.

Try to answer the following questions:

- How is the azimutal resolution of a SLR related to the height of the antenna above the ground?
- What are the pros/cons of using a side-looking geometry?
- What types of image distortions occur and how can we get rid of them?

Exercise 2: Synthetic Aperture Radar

Explain and visualize the frequency shift of a target as seen by a Synthetic Aperture Radar as it moves across its footprint.

Try to answer the following questions:

- How does a SAR-system work?
- Which parameters influence the induced frequency-shift?
- What are the benefits of a SAR-system compared to a real-aperture radar?
- How does the ground resolution of a SAR-system relate to the flying height and the antenna size, as opposed to real-aperture antennas?
- (optional bonus-question) What do we mean by focused/unfocused SAR?

Exercise 3: Altimeter

Simulate and explain the echo of an altimeter observing a flat terrain by assuming a constant power-pattern across the beamwidth.

Try to answer the following questions:

- How does the measurement-principle of an altimeter work?
- What is the difference between a pulse-limited and a beam-limited altimeter?
- What happens if the transmitted power across the beamwidth is not isotropic?
- How does a rough-surface affect the measured signal?

Exercise 4: Frequency Modulated Radar

Visualize and explain the operation of a frequency-modulated radar.

Try to answer the following questions:

- How does a FM-Radar (in principle) work?
- What is the main quantity governing the resolution of a FM-Radar?
- How does an FM-Radar differ from an ordinary Pulse-Radar?

Exercises for Chapter 5

Exercise 1: Snell's Law

Visualize and explain Snell's law by illustrating the propagation of a monochromatic, linearly polarized wave at the boundary between two media with different refractive indexes.

Hint: You can represent the incoming, reflected and transmitted wave as linear rays in propagation direction, and the wave-fronts as lines perpendicular to the direction of propagation.

Try to answer the following questions:

- How do the reflected / transmitted angle depend on the incidence angle and on the index of refraction of the lower medium (the upper medium can be assumed as vacuum)?
- What is the "critical angle of refraction"? Also visualize it.

Exercise 2: Fresnel coefficients

Visualize and explain the behavior of the dielectric constant of water (20°C) in the visible and in the microwave domain as a function of frequency.

Try to answer the following questions:

- How does the **reflectivity** of water (20°C) for horizontally and vertically polarized waves behave as a function of the incidence angle and depending on the frequency? The water can be considered lossless.
- What is the Brewster angle? Also visualize it.