

Assignment 7: Estimation of Range Profiles

Due: Tuesday, May 27

Range estimation

The purpose of this exercise is to perform step-frequency FMCW radar imaging using *FFT* for range estimation.

The data set was taken over a section of the walkway pavement in front of the Broida Hall. The ground-penetrating radar imaging unit scanned along a linear path and took data at 200 spatial positions. The spatial spacing between the data-collection positions is 0.0213 m (2.13 cm).

At each data-collection position, the system illuminates the subsurface region of the walkway area with microwaves in the step-frequency (FMCW) mode, stepping through 128 frequencies with a constant increment, from 0.976 GHz to 2.00 GHz. The relative permittivity ϵ_r is approximately 6.0.

The data set is in the form of a (200×128) array, corresponding to 128 complex-amplitude values (for the 128 frequencies) at 200 data-acquisition positions.

Your task is to perform the image reconstruction of the subsurface profile. The result will be an image compiled in the form of 200 depth profiles corresponding to the 200 data-acquisition positions.

Please note:

- (a) The propagation speed needs to be adjusted by the relative permittivity.
- (b) The depth profile needs to be scaled by a factor of two for the round-trip propagation.
- (c) The intensity of the depth profiles near the transceiver is due to strong surface reflection. It should be gated out in order to visualize the depth profiles adequately.
- (d) The rebars are at shallow depths. Thus, the displayed profiles up to 20-30 cm will be sufficient.
- (e) The image should be adjusted such that the spatial scale of the pixel size of the image is approximately the same in both directions for realistic visualization.

Your report should include:

- (1) a detailed description of your approach and the signal processing procedures,
- (2) resolution limit of the depth profiles and the maximum detectable depth,
- (3) physical pixel size in both directions of the final image,
- (4) final image,
- (5) code, and
- (6) a short summary.