ECE 278C **IMAGING SYSTEMS** **Winter 2024**

ASSIGNMENT 6: Multi-Frequency Ground-Penetrating Radar (GPR) Imaging

Due: Tuesday, March 5

The objective of this assignment is to apply the multi-frequency backward propagation technique implemented for Assignments 4 and 5 to FMCW ground-penetrating radar imaging.

The data set was taken over 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 walkway pavement with microwaves in the step-frequency monostatic 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 organized in the form of a *(200 x 128)* array, corresponding to *128* complex-amplitude values (for the 128 frequencies) at 200 receiving positions.

Your results are in the form of two-dimensional image plots. Please note:

1. The propagation speed needs to be adjusted by the relative permittivity.
2. The depth profile needs to be scaled by a factor of two for the round-trip propagation.
3. For simplicity, use the phase-only version of the Green's function for coherent backward propagation.

Part A:

Your task is to perform the image reconstruction of the subsurface profile by using multi-frequency backward propagation, as you conducted in Assignment 4.

There are 128 coherent sub-images, corresponding to the 128 frequencies (128 wavelengths). Your goal is to produce a 128-frame video to illustrate the convergence to the final image and the effect due to the increase of frequency bandwidth.

Part B:

Your task is to perform the image reconstruction of the subsurface profile by superimposing the range profiles, as you conducted in Assignment 5.

There are 200 range profiles, corresponding to the 200 transceiver positions. Your goal is to produce a 200-frame video to illustrate the convergence to the final image and the effect due to the increase of data-acquisition aperture.

Attachments: *(200 x 128)* data array

Report:

1. Cover sheet
2. Description of your algorithm (please include a diagram)
3. Code
4. Composite image (final image)
5. Summary
6. Video of the 128-frame image sequence (bandwidth effect)
7. Video of the 200-frame image sequence (aperture effect)