Radar System Project REPORT

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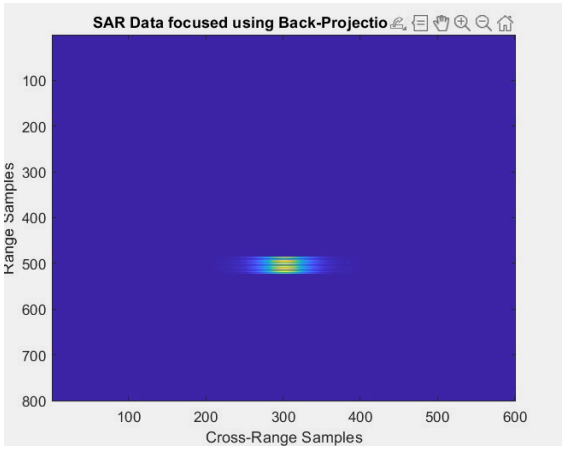
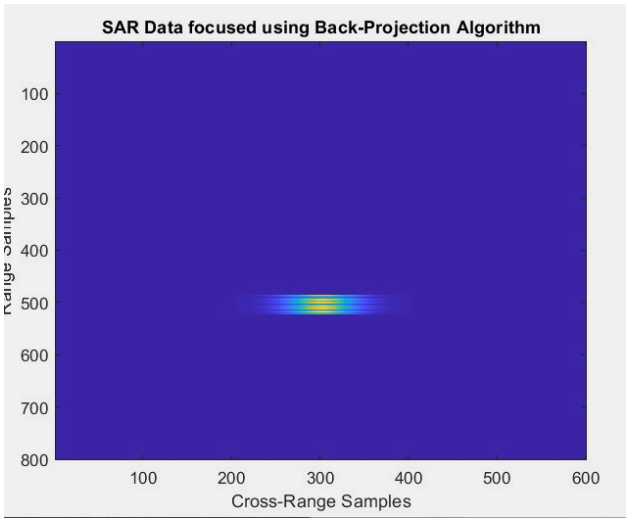
Group 10

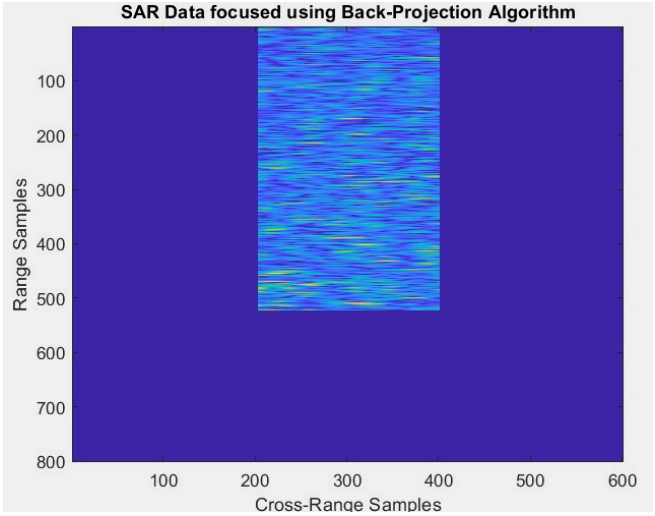
Part 4 Observations for different radar parameters:



- The SAR system, operating at 6 GHz with a PRF of 3000 Hz, a platform velocity of 300 m/s, and altitude of 1500 m, successfully detects and focuses a target using Back-Projection. The high transmitted power (1500 W) and antenna gain (60 dB) ensure good SNR, while the platform parameters support fine resolution in both range and cross-range, as seen in the concentrated target signature around (400, 500). No ambiguities are expected given the PRF and range.



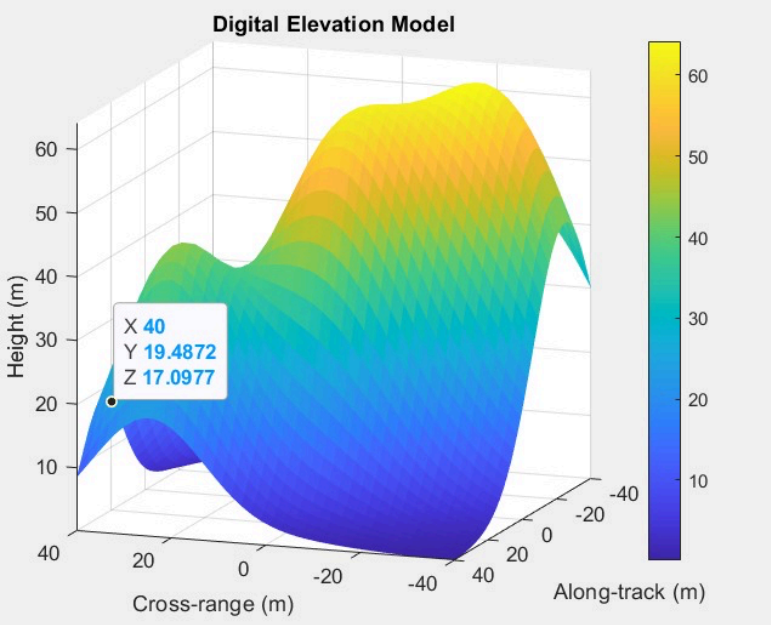
- The SAR system at 4 GHz, with a PRF of 3000 Hz, platform velocity of 300 m/s, and altitude of 1500 m, effectively detects and focuses a target using Back-Projection. The high power (2000 W) and gain (50 dB) ensure good SNR, and the platform parameters support fine resolution, as seen in the concentrated target signature. No ambiguities are present.

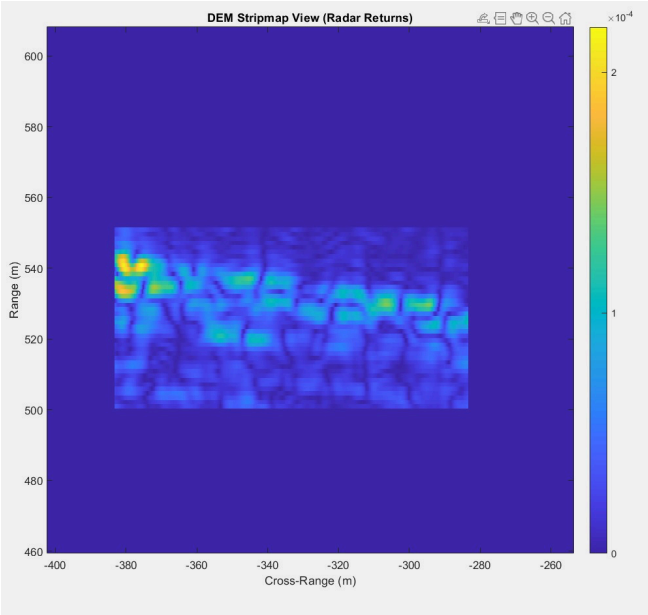


- The SAR system at 5 GHz, with a PRF of 3000 Hz, platform velocity of 300 m/s, and altitude of 1700 m, shows a diffuse, noisy pattern rather than a focused target. The high transmitted power (3000 W) is undermined by the low antenna gain (10 dB),

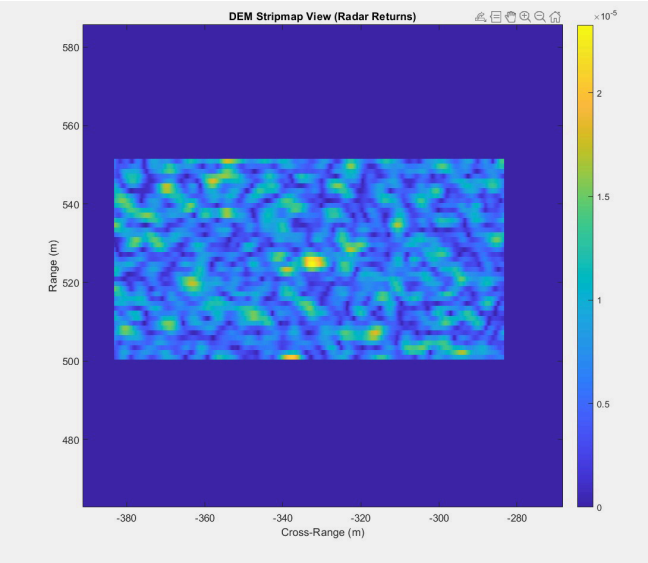
leading to a poor SNR and degraded focusing, as seen in the broad intensity region. The Back-Projection algorithm struggles to produce a sharp image under these conditions. For better focusing, increasing the antenna gain would be critical.

Part 5 Observations for different radar parameters:



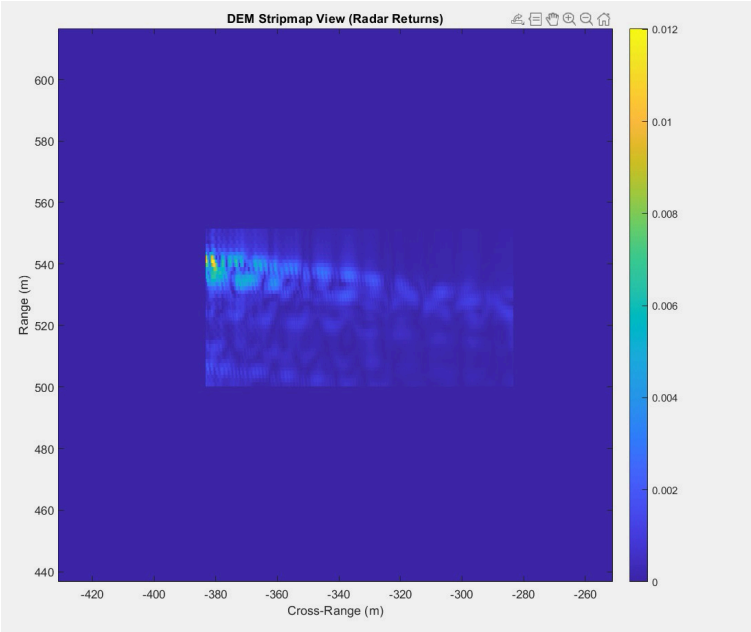


- The SAR system at 4 GHz, with a PRF of 3000 Hz, platform velocity of 300 m/s, and altitude of 1500 m, images a terrain strip with a ridge, as confirmed by the DEM. The strong radar returns at (-380, 540) correspond to the elevated ridge (peak height ~50 m), with the Back-Projection algorithm effectively mapping the terrain. The high power (2000 W) and gain (50 dB) ensure good SNR, and no range ambiguities are present. The distributed returns reflect the terrain's topography rather than a single target, unlike previous plots.



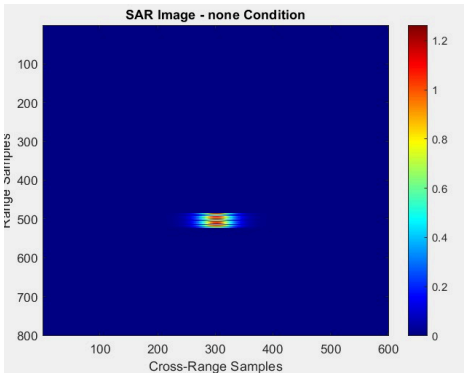
- The SAR system at 5 GHz, with a PRF of 3000 Hz, platform velocity of 300

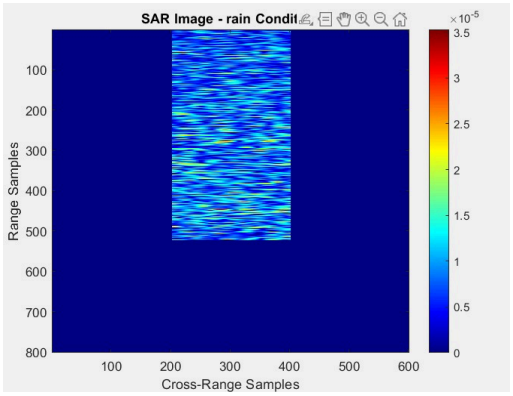
m/s, and altitude of 1700 m, images a terrain strip with a ridge (peak ~50 m), as shown in the DEM. The strong returns near (-330, 540) correspond to the ridge, but the low antenna gain (10 dB) results in noisy, diffuse returns compared to higher-gain scenarios. The high power (3000 W) helps, but cannot fully compensate for the low SNR. No range ambiguities are present. For better focusing, increasing the antenna gain would be crucial.

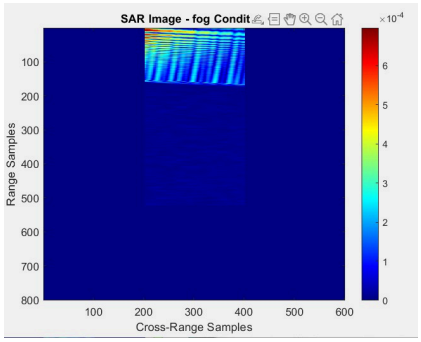


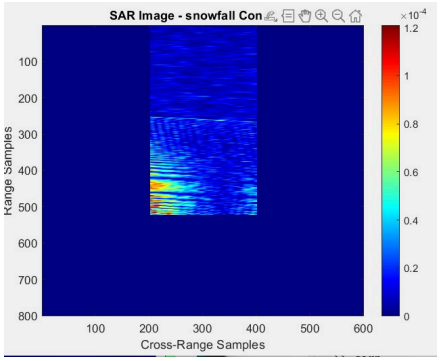
- The SAR system at 6 GHz, with a PRF of 3000 Hz, platform velocity of 300 m/s, and altitude of 1500 m, images a terrain strip with a ridge (peak ~50 m), as shown in the DEM. The strong returns near (-380, 520) correspond to the ridge, with the high antenna gain (60 dB) enabling focused imaging despite the terrain's complexity. The power (1500 W) and gain ensure a high SNR, and no range ambiguities are present.

Part 6 Observations for different radar parameters:

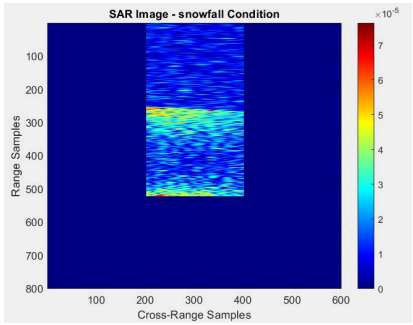


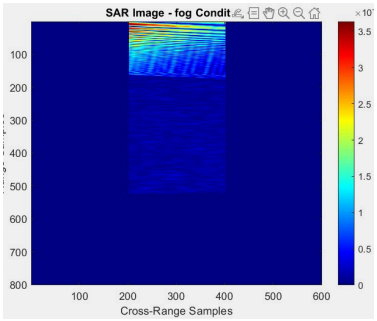


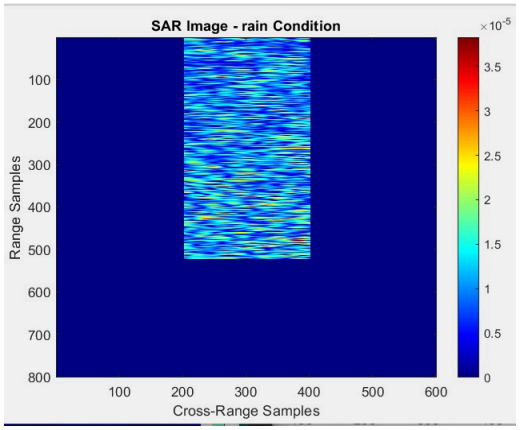


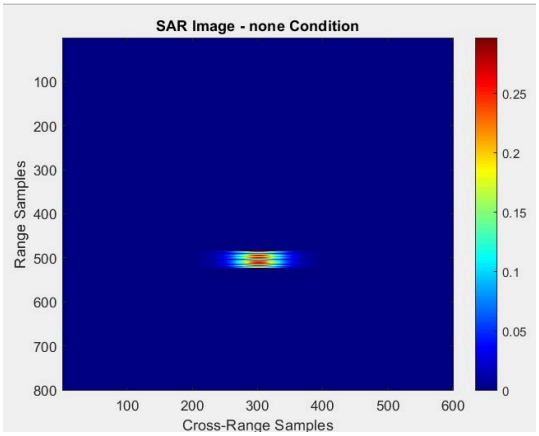


- The SAR system at 6 GHz, with a PRF of 3000 Hz, platform velocity of 300 m/s, and altitude of 1500 m, images a point target under varying conditions. In clear conditions, the target is sharply focused at (400, 500), thanks to the high gain (60 dB) and power (1500 W). Rain causes the most degradation (high noise, broad signature), followed by snowfall, then fog, due to increasing attenuation and scattering at 6 GHz. The Back-Projection algorithm struggles with weather-induced phase distortions, reducing focus in adverse conditions.

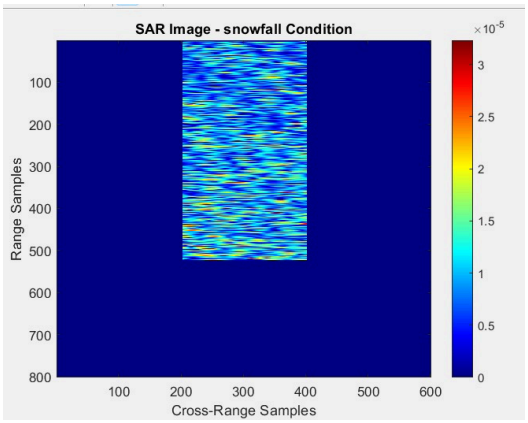


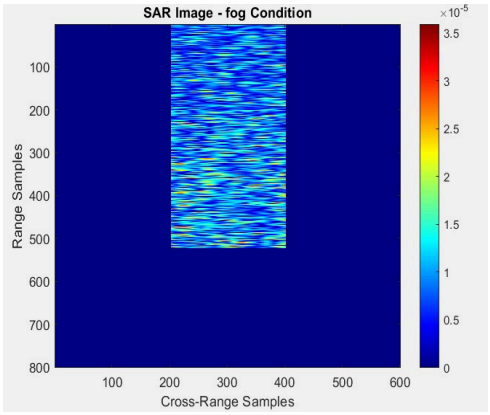


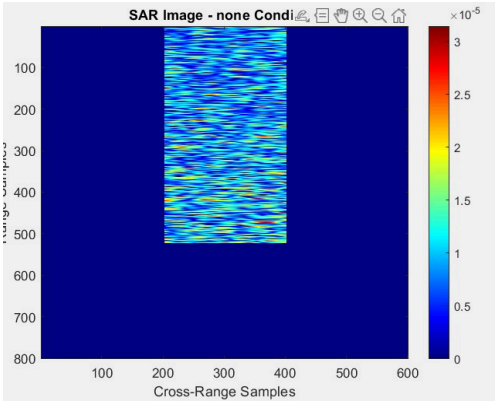


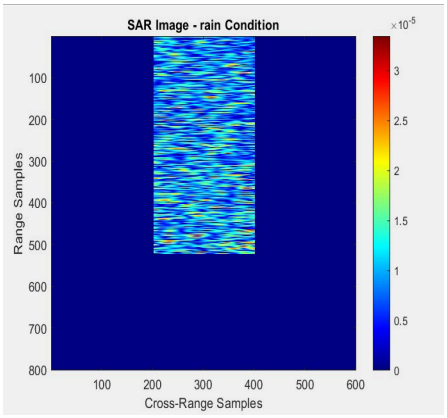


- The SAR system at 4 GHz, with a PRF of 3000 Hz, platform velocity of 300 m/s, and altitude of 1500 m, images a point target under varying conditions. In clear conditions, the target is sharply focused at (400, 500), with good SNR from the gain (50 dB) and power (2000 W). Rain causes the most degradation (high noise, broad signature), followed by snowfall, then fog, due to increasing attenuation and scattering at 4 GHz. The Back-Projection algorithm struggles with weather-induced distortions, though the lower frequency mitigates some attenuation compared to 6 GHz.









- The SAR system at 5 GHz, with a PRF of 3000 Hz, platform velocity of 300 m/s, and altitude of 1700 m, images a point target under varying conditions. The low antenna gain (10 dB) results in a diffuse, noisy baseline image in the "none" condition, with the target at (400, 500) barely focused. Weather conditions (rain, fog, snowfall) add marginal degradation due to the already poor SNR, with rain causing the most noise, followed by snowfall and fog. The high power (3000 W) ensures detectability, but the Back-Projection algorithm cannot achieve sharp focus. Increasing the antenna gain would significantly improve performance.

Work Distribution for Radar Project:

- Nishchal: Implements Back-Projection Algorithm Development.
- Manan Kadecha: Environmental Simulation and Performance Analysis
- Aarya: Radar System Setup and Parameter Optimization