Cross-range Imaging

A single frequency radar signal $p(t) = \exp(j\omega t)$ is used, with carrier frequency $f_c = 200$ MHz. The mean cross-range of the target area is $Y_c = 500$ meters. The cross-range size of the target area is $Y_0 = 200$ meters, and the synthetic aperture length is $L = 150$ meters. Four targets are located in the target area. Their x-coordinate is fixed at $X_c = 2000$ meters, and their y-coordinates are $Y_c + y_n$, $n = 1, \cdots, 4$, $y_1 = 0$, $y_2 = 0.7Y_0$, $y_3 = 0.6Y_0$, and $y_4 = -0.8Y_0$. The corresponding reflectivity is $\sigma_1 = 1$, $\sigma_2 = 0.8$, $\sigma_3 = 1$, $\sigma_4 = 0.6$. Perform slow-time compression to reduce the pulse repetition frequency (PRF). In addition, since $Y_0 > L$, zero-padding the synthetic aperture signal $s(\omega, u)$ in u domain is needed to create an effective aperture of $[-Y_0, Y_0]$.

Complete Matlab programming that generates the following results. Submit a printed report that includes 1. Figures of the results; 2. Analysis of the results (describe your observations and provide analysis of these observations); 3. Attach the Matlab code for all problems. In addition, submit the Matlab code that can be compiled to generate all the results in one .zip file to yl72@buffalo.edu.

Note: this is an individual project and please complete the project independently.

P2.1 Sample the synthetic aperture signal $s(\omega, u)$ with the compressed signal's sample spacing Δ_{uc}, and perform baseband conversion. Plot the real part of the resultant baseband aliased measured signal $\mathrm{Re}[s_b(\omega, u)]$ in the slow-time u domain.

P2.2 Plot the baseband aliased synthetic aperture signal spectrum $|S_b(\omega, k_u)|$ versus k_u.

P2.3 Perform signal compression in u domain and plot the real part of the compressed synthetic aperture signal $\mathrm{Re}[s_c(\omega, u)]$ versus u.

P2.4 Plot the compressed synthetic aperture signal spectrum $|S_c(\omega, k_u)|$ versus k_u. Again plot $|S_c(\omega, k_u)|$ in the cross-range domain y (i.e. plot $|S_c(\omega, y)|$).