

1. Write an autofocus program to implement the sub-aperture shift algorithm.

Use a 1-D image for ease of implementation. Assume the signal is a single chirp waveform with the following parameters:

Chirp slope:	10^{12} Hz/s
Pulse length:	10 μ s
Sample rate fs:	100 Mhz

Correlate this chirp with reference chirps of slope $1 \cdot 10^{12}$ Hz/s, $1.01 \cdot 10^{12}$ Hz/s, $1.03 \cdot 10^{12}$ Hz/s, and $0.98 \cdot 10^{12}$ Hz/s. In each case analyze the resulting complex image and calculate

- (a) the offset in pixels of the subaperture images
- (b) the implied Δs for each case

2. Download the data file “simlband.dat” from the web page. This file represents signal data in **complex floating point** format, 2048 lines of 2048 complex samples each. Display the file and note the range migration present. (You may have to byte-swap the file if your machine is big-endian.)

- (a) Range compress the data and examine the migration as a function of time. Chirp parameters are:

Chirp slope:	10^{12} Hz/s
Pulse length:	10 μ s
Sample rate fs:	24 Mhz

- (b) Transform the compressed data in azimuth and display, again noting the migration path. Other radar parameters are:

PRF:	250 Hz
Velocity:	250 m/s
Antenna length:	2 m
Wavelength:	0.25 m
Range to first bin:	4653 m

- (c) Estimate the Doppler centroid of the data. List at least three possible f_{DC}'s consistent with the ambiguous measurement of f_{DC}.

- (d) Process these data using the original (non-migrating) algorithm. Examine and plot the impulse response and describe the blurring. Process 80% of the azimuth

bandwidth.

(e) Apply the cut and paste algorithm assuming each f_{DC} found in (c) above. Which gives the best impulse response? Again use 80% bandwidth.

3. In class we showed that for a satellite passing directly overhead, the effective velocity for SAR processing was

$$v_{\text{eff}} = v \sqrt{\frac{r_e}{h + r_e}}$$

Show that for a point not directly under the satellite,

$$v_{\text{eff}} = v \sqrt{\frac{r_e \cos \beta}{h + r_e}}$$

where β is the angle from the point, to the center of the Earth, to the satellite at its point of closest approach.