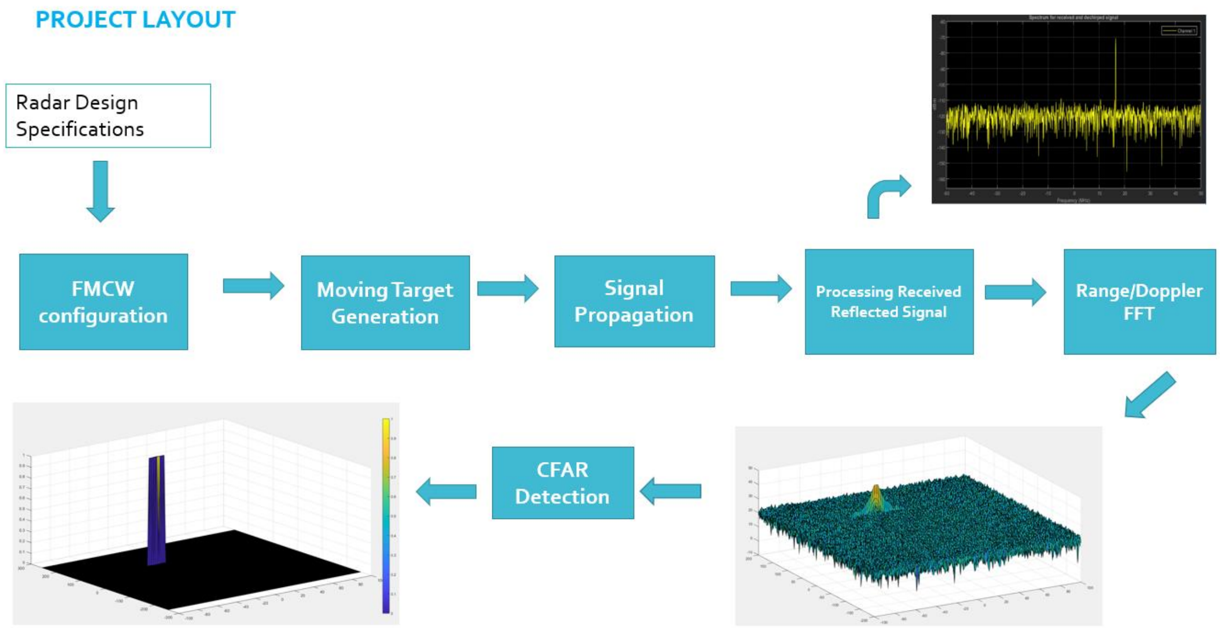
Radar Target Generation and Detection



Project steps:

- Configure the FMCW waveform based on the system requirements.
- Define the range and velocity of target and simulate its displacement.
- For the same simulation loop process the transmit and receive signal to determine the beat signal
- Perform Range FFT on the received signal to determine the Range
- Towards the end, perform the CFAR processing on the output of 2nd FFT to display the target.

Radar System Requirements:

Frequency	**77 GHz**
Range Resolution	1 m
Max Range	200 m
Max velocity	70 m/s
Velocity resolution	3 m/s

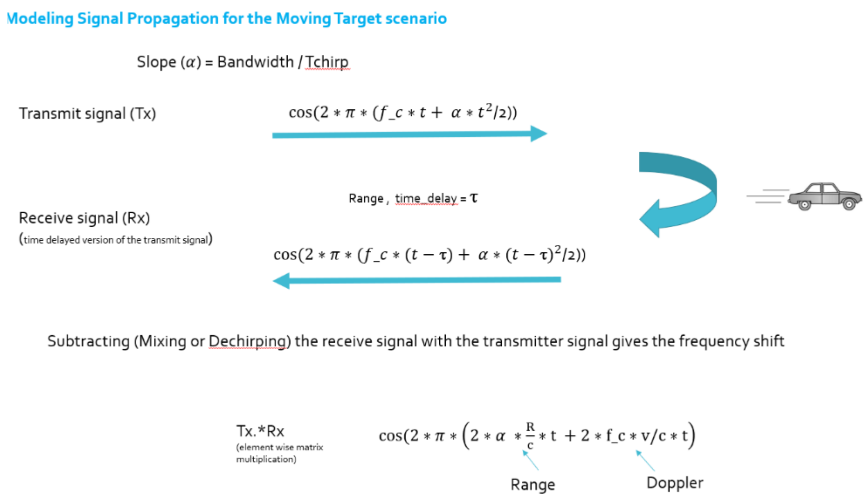
PROJECT SPECIFICATION

1. FMCW Waveform Design

Max Range and Range Resolution will be considered here for waveform design.

- $Bandwidth(Bsweep)=speedoflight/(2*rangeResolution)$
- $Tchirp=5.5\cdot 2\cdot Rmax/c$
- $Slope=Bandwidth/Tchirp$

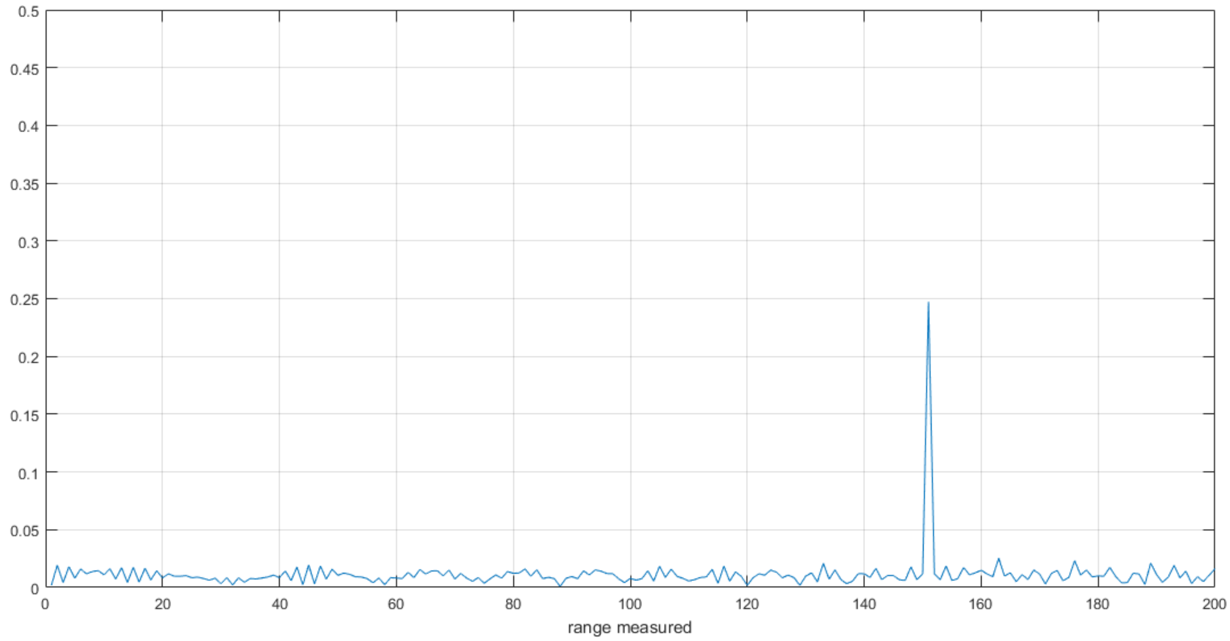
2. Simulation Loop



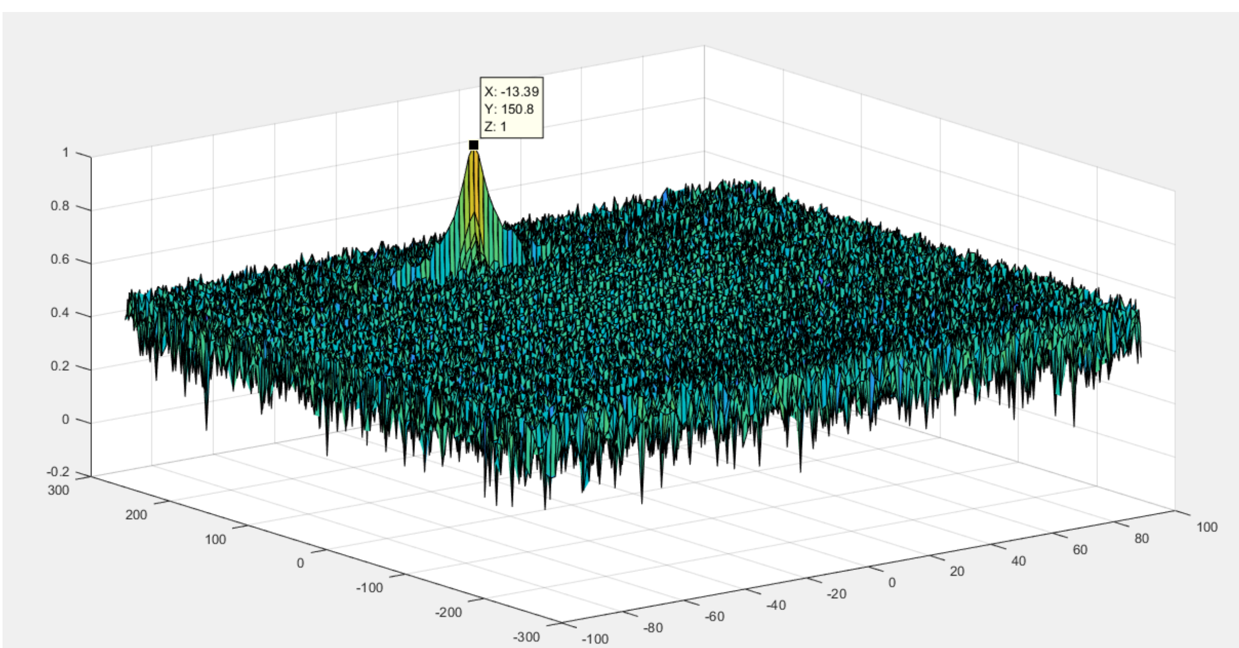
3. Range FFT (1st FFT)

- Implement the 1D FFT on the Mixed Signal
- Reshape the vector into Nr*Nd array.
- Run the FFT on the beat signal along the range bins dimension (Nr)
- Normalize the FFT output.
- Take the absolute value of that output.
- Keep one half of the signal
- Plot the output
- There should be a peak at the initial position of the target

Output:



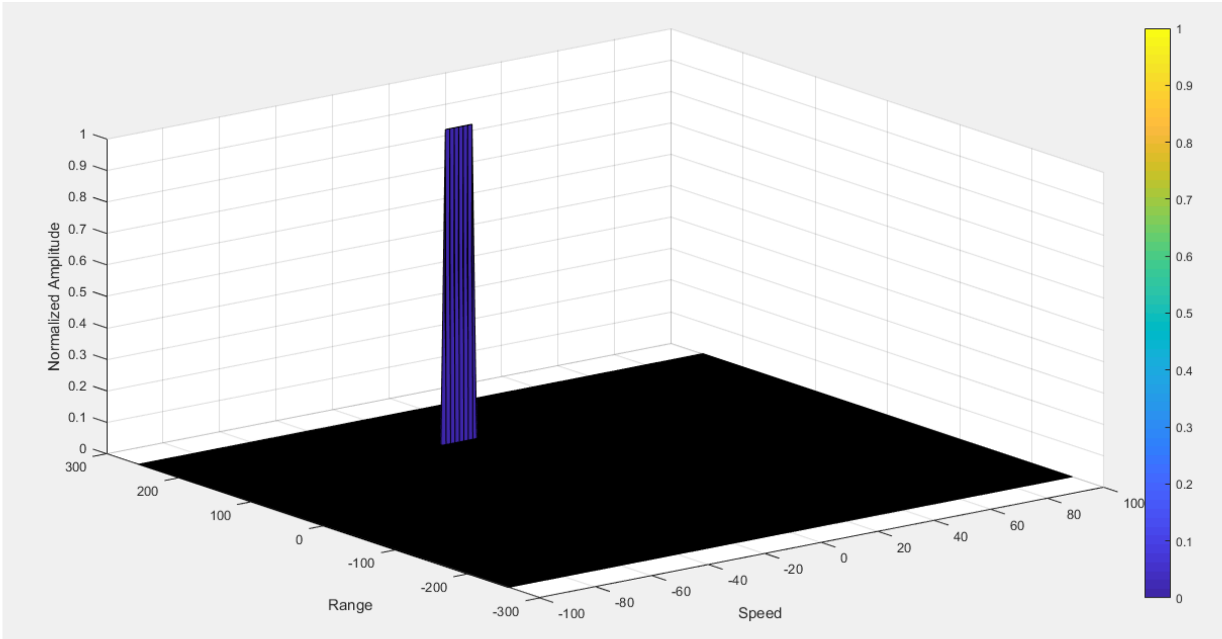
The 1st FFT output for the target located at 90 meters



2D FFT output - Range Doppler Map

4. 2D CFAR
    - Select the number of Training Cells in both the dimensions.
      Tr = 10;
      Td = 8;
    - Select the number of Guard Cells in both dimensions around the Cell under test (CUT) for accurate estimation
      Gr = 4;
      Gd = 4;
    - Offset the threshold by SNR value in dB
      offset = 1.3;

    - Create a vector to store noise level for each iteration on training cells
    - Loop over RDM to select each CUT
    - For each selection, sum their values after removing guard cells
    - Find average of noise level value
    - Use pow2db to convert back the value of noise to get threshod with offset added to it
    - If the CUT level > threshold assign it a value of 1, else equate it to 0.
    - Steps taken to suppress the non-thresholded cells at the edges: by equating all the non-thresholded cells to 0:
      RDM(union(1:(Tr+Gr),end-(Tr+Gr-1):end),:) = 0; % Rows
      RDM(:,union(1:(Td+Gd),end-(Td+Gd-1):end)) = 0; % Columns



The output of the 2D CFAR process