Range Resolution

Radar range resolution is the capability of the radar to distinguish or resolve nearby adjacent targets in the range. The degree of range resolution depends on the width of the transmitted pulse hence it is inversely proportional to bandwidth of the transmitted signal. Range resolution can get by below equation.

$$\text{Range Resolution} = \frac{c}{2*Bandwidth}$$

As per the equation, when bandwidth go from 100Mhz -> 150MHz, range resolution up by 1.5 time. For 300MHz it is 3 times and for 400MHz it is 4 times better than 100MHz range resolution.

Velocity Resolution

$$\text{Velocity Resolution} = \frac{\Lambda}{2*T*N}$$

Velocity resolution inversely proportional to sweep time (T) and by increasing T to 2ms lead to improve velocity resolution by factor of 2 for 4ms factor of 4 and 10ms factor of 10.

Max unambiguous range

The maximum unambiguous range is the longest range to which a transmitted pulse can travel out to and back again between consecutive transmitted pulses. In other words, it is the maximum distance radar energy can travel round trip between pulses and still produce reliable information. Max unambiguous range is inversely proportional to bandwidth.

$$\text{Max unambiguous range} = \frac{C*Tm*Fs}{4*\Delta\mathrm{F}}$$

Tm = sweep duration, Fs = N/T, ΔF bandwidth (Hz)

Max unambiguous Velocity

The highest radial velocity that can be measured unambiguously by a pulsed Doppler radar. The maximum unambiguous velocity is related to the radar's successive pulses of emitted energy. When a target's velocity exceeds the maximum unambiguous velocity, the velocity will be appeared as a different velocity.

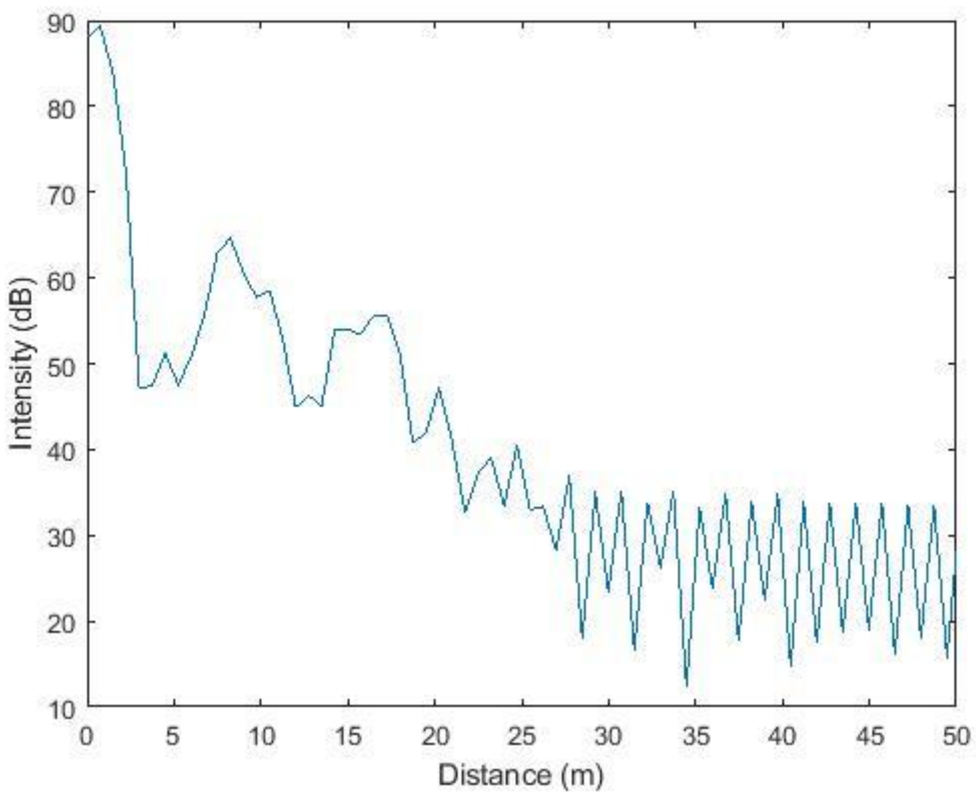
$$\text{Max unambiguous Velocity} = \frac{\Lambda*\text{Sampling frequency}}{4}$$

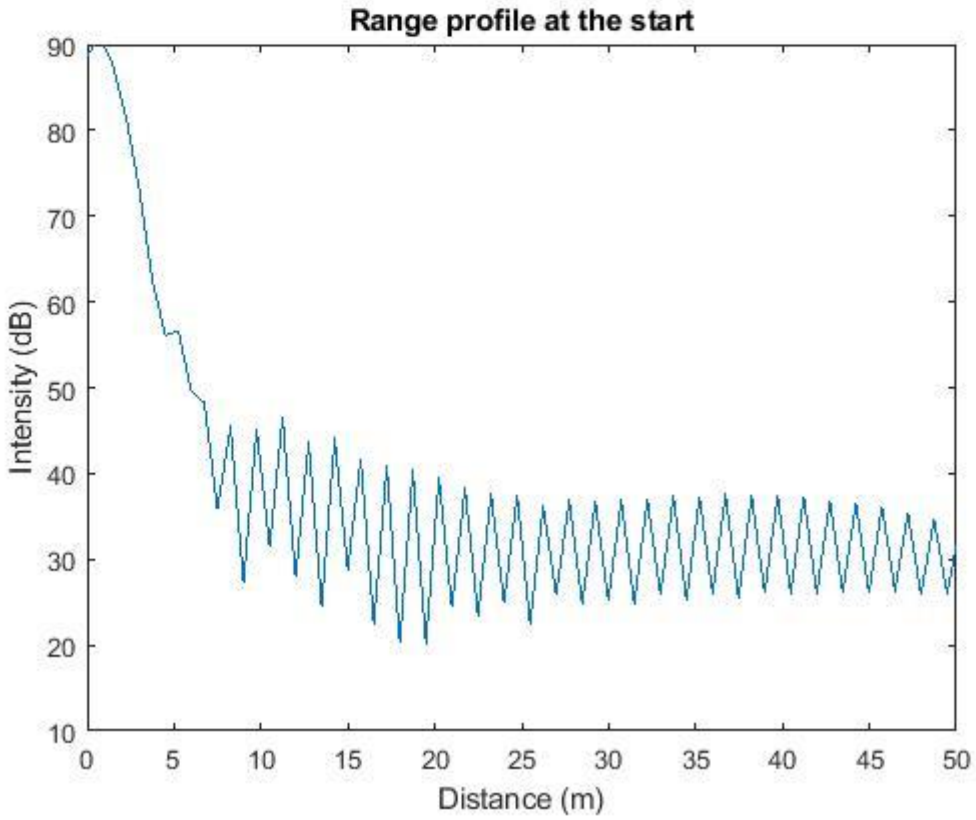
b)

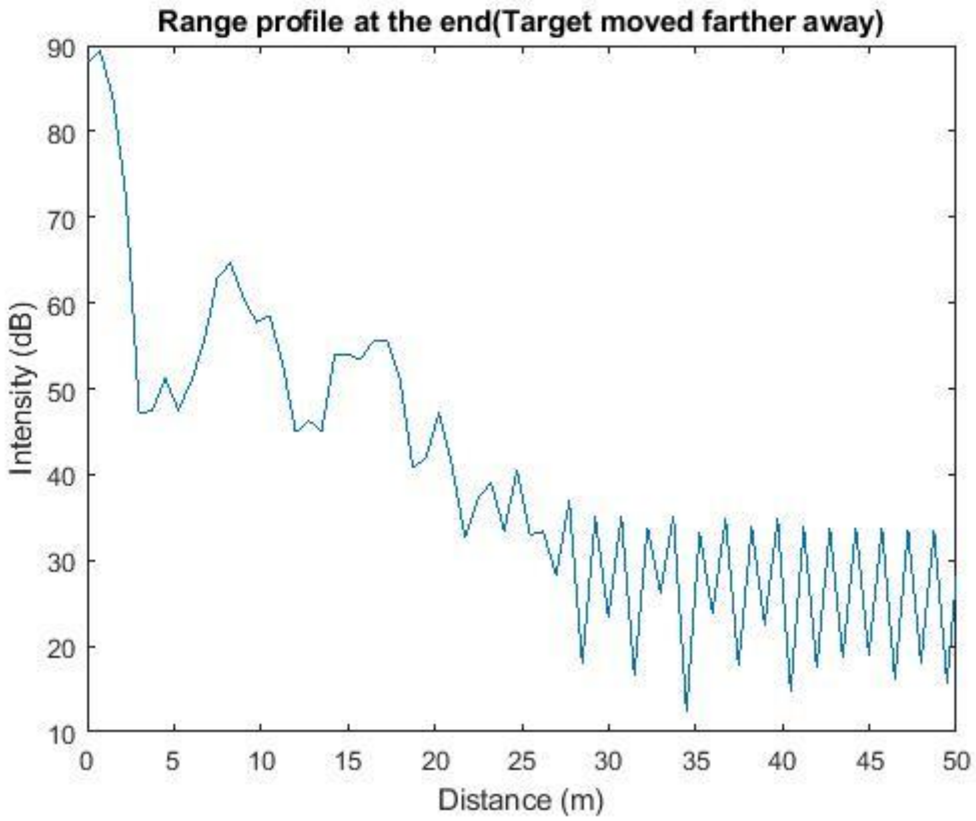
Matlab Code

```
clear;
close all;
clc;
addpath('data/');


c = physconst('LightSpeed');

%% SDR parameters

filename = 'MeasuredData.dat'; % File name
fileID = fopen(filename,'r');
dataArray = textscan(fileID,'%f');
fclose(fileID);
radarData = dataArray{1};
clearvars fileID dataArray ans;

fc = radarData(1);          % Center frequency
Tsweep = radarData(2);      % Sweep time in ms
NTS = radarData(3);         % Number of time samples per sweep
Bw = radarData(4);          % FMCW Bandwidth. For FSK, it is frequency step;  For
CW, it is 0.
Data = radarData(5:end);    % raw data in I+j*Q format
Data_1 = Data(1:2:end);     % Data of channel 1
Data_2 = Data(2:2:end);     % Data of channel 2
recorded_time = 5;          % seconds

%% Range profile processing
% In this exercise, we only process the data received by the first channel

% Calculate number of sweeps contained in the recorded data
numberSweeps = length(Data_1)/NTS;
psd_matrix = zeros(513,2500);

% Create a loop to process each sweep
for index = 0:1:(numberSweeps-1)


    signal = Data_1(NTS*index+1:NTS*index+NTS);
    signal = signal.*hamming(NTS);
    FFT_size = 1024;
    samp_rate = NTS*1e3/Tsweep;
    fsignal = fft(signal, FFT_size);
    psdx = abs(fsignal(1:FFT_size/2+1)).^2/length(fsignal);
    psdx(2:end-1) = 2*psdx(2:end-1);
    psd = 10*log10(psdx);

    % Obtain the range vector
    Rng = c*linspace(0, samp_rate, FFT_size/2+1)/2*(Tsweep*1e-3)/(2*Bw);
    psd_matrix(:,index+1) = psd;

    % Plot the range profile response (Intensity (dB) vs. Distance (m))
    figure(1)
    plot(Rng,psd)
    xlim([0 50])
```

```
    ylim([10 90])
    xlabel('Distance (m)')
    ylabel('Intensity (dB)')
    drawnow
 %%
    % Plot the range profile response (Intensity (dB) vs Distance (m))
    if index == 0
        figure(2)
        plot(Rng, psd)
        xlim([0 50])
        ylim([10 90])
        xlabel('Distance (m)')
        ylabel('Intensity (dB)')
        title("Range profile at the start")
    elseif index==numberSweeps-1
        figure(3)
        plot(Rng,psd)
        xlim([0 50])
        ylim([10 90])
        xlabel('Distance (m)')
        ylabel('Intensity (dB)')
        title("Range profile at the end(Target moved farther away)")
    end
end
```




Range profile at the start
90
80
70
60
50
40
30
20
10
Intensity (dB)
0
5
10
15
20
25
30
35
40
45
50
Distance (m)


Range profile at the end(Target moved farther away)
90
80
70
60
50
40
30
20
10
Intensity (dB)
0
5
10
15
20
25
30
35
40
45
50
Distance (m)