SFND-Radar Target Generation and Detection

This project is an implementation for the “Radar Target Generation and Detection” in the Sensor Fusion Nanodegree.

Implementation steps for the 2D CFAR process

- Determine the number of Training cells for each dimension Tr and Td. Similarly, pick the number of guard cells Gr and Gd.
- Slide the Cell Under Test (CUT) across the complete cell matrix
- Loop over elements of RDM array each iteration selecting one cell to be the cell under test.
  for i = Tr+Gr+1 : (Nr/2)-(Gr+Tr)
  for j = Td+Gd+1 : Nd-(Gd+Td)
- For each iteration loop over the training cells "excluding the guarding cells:
  for p = i-(Tr+Gr) : i+(Tr+Gr)
  for q = j-(Td+Gd) : j+(Td+Gd)
- Measure and average the noise across all the training cells.
  noise_level = noise_level + db2pow(RDM(p,q));
- This gives the Training Cells : (2Tr+2Gr+1)(2Td+2Gd+1) - (2Gr+1)(2Gd+1)
- Convert using pow2db dividing noise_level by the Training Cells
  th = pow2db(noise_level/(2*(Td+Gd+1)*2*(Tr+Gr+1)-(Gr*Gd)-1));
- Add the offset value th = th + offset
- If the CUT signal level is greater than the Threshold, assign a value of 1, else equate it to zero.

Selection of Training, Guard cells and offset

These 2 sets of parameters worked well in most range of velocity and range:(r for range & d for doppler)

- Tr = 10, Td = 8 , Gr = 4, Gd = 4 , offset = 1.4
- Tr = 12, Td = 10 , Gr = 5, Gd = 5 , offset = 1.3

If the offset was smaller with the same Training and guard cells , So much noise appear.

If the offset was larger with the same Training and guard cells , The velocity component doesn’t appear.

Steps taken to suppress the non-thresholded cells at the edges

The process above will generate a thresholded block, which is smaller than the Range Doppler Map as the CUTs cannot be located at the edges of the matrix due to the presence of Target and Guard cells. Hence, those cells will not be thresholded.

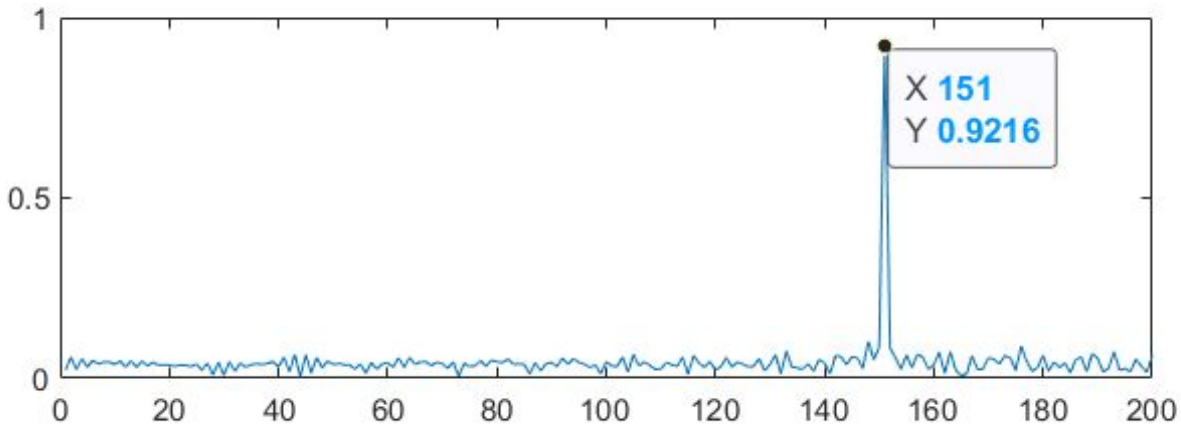
This was done by slicing the output such that we have the surrounding rows and columns only depending on the Training cells for both range and doppler.

```
RDM(union(1:(Tr+Gr),end-(Tr+Gr-1):end),:) = 0; % Rows
RDM(:,union(1:(Td+Gd),end-(Td+Gd-1):end)) = 0; % Columns
```

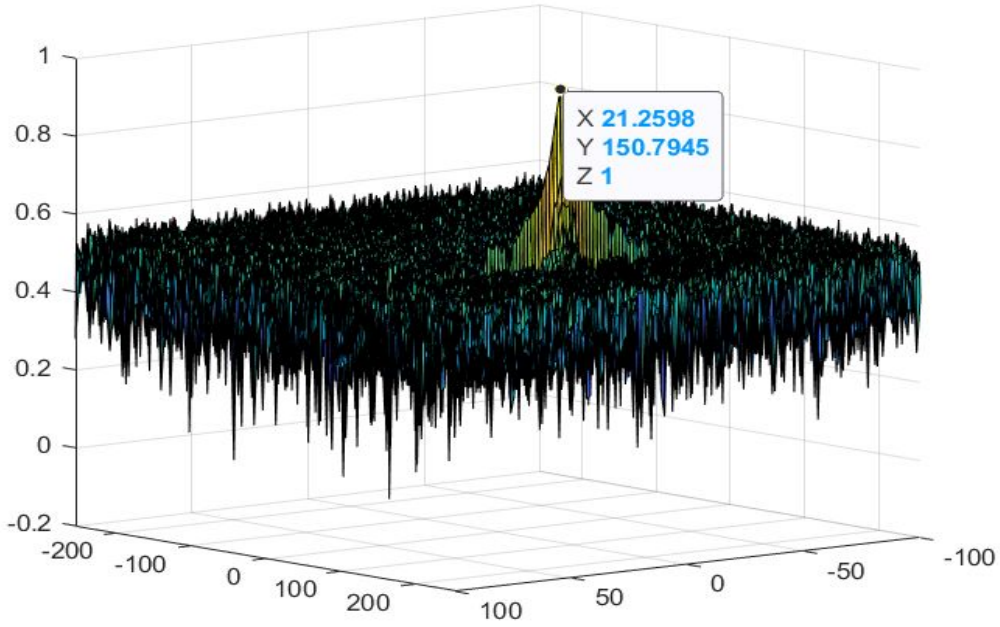
Output:

This is the output for a target at 150m moving at 20 m/s relative speed.

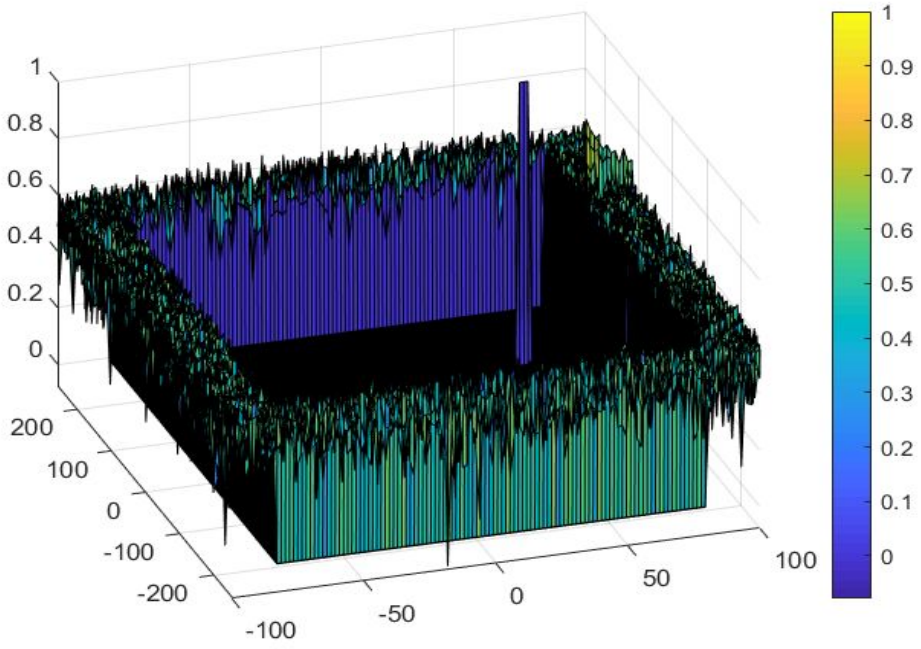
Output of FFT : (range =~ 150.0)



Output of FFT2 : (doppler =~ 20.0)



Output of CFAR (without suppressing the non-thresholded cells)



Final Output: