University of Moratuwa
Faculty of Engineering
Department of Electronic & Telecommunication Engineering
EN4353 Radar and Navigation

Assignment 5

B.Sc Engineering, Semester 8 2016 Batch

Introduction

In this assignment you will be analyzing a real-world dataset ***dataset.csv*** to extract useful information to visualize and identify the clutter map for a monostatic **MTD** (Moving Target Detection) surveillance radar.

Description

In the csv file you are given data from an actual radar whose pulse repetition interval is 900μs but here the actual pulse transmission and reception is only done in the first 600μs and the other 300μs is used for other processing work. Note that this 600μs also includes the radar blind period also. The width of the transmitted pulse is 14μs.

Antenna shaft encoder produce 4096 Azimuth Counter Pulses (ACPs) during one complete revolution of the antenna. One cycle of the ACP signal consists of 22500 samples from the over-sampled signal. The Coherent Processing Interval (CPI) of the MTD consists of 32 ACPs. A CPI forms one azimuth bin that correponds with the antenna beamwidth. There are 128 CPIs during one revolution of the antenna.

The data from the radar was sampled at a rate of 4MHz however when storing, it has been over-sampled and stored as 16 bit 2's complement numbers in hex format. Additionally, it was noted that the first 10650 samples from the original signal (not the over-sampled signal) was erroneous and is needed to be dropped when processing further. More over, it was noted that the **I** channel has not been biased properly when acquiring the dataset and hence, the 4 most significant bits has been denoted by the hex value '7' when it should have been 'F'(this change should be done only when the first hex value is '7'). Therefore, this dataset needs to be subjected to preprocessing.

(**Q1**) Analyze the dataset and describe the oversampling procedure and the over-sampling factor. Downsample the signals accordingly.

(**Q2**) Extract data corresponding to each $I(t)$ and $Q(t)$ columns and obtain the $|I(t)+jQ(t)|$, $I(t)$ and $Q(t)$ plots for the 1^{st} pulse and the 20^{th} pulse as subplots for each case.

(**Q3**) By observing the plot of $|I(t) + jQ(t)|$ decide a suitable threshold.

(**Q4**) It is known that at this moment in time there are **no moving** targets in the vicinity of the radar. Your objective here is to obtain the clutter map (in the form of a radar matrix) as in **MTD** by using the threshold found in (Q3).

(**Q5**) Estimate the following parameters.
i. RPM of the radar
ii. Numbers of echoes per CPI interval
iii. Beam width of the radar.

(**Q6**) Interpret the clutter map you found in (Q4) and explain how the radar would use it for MTD.

Submission Details:

You are expected to use ***Python*** language to analyze the dataset. The details of the implementation must be properly explained in your **report** along with the necessary calculations and visualization. You must submit the report and codes (in the format of ***.ipynb***). A clean and a tidy work is appreciated

References

1. You can use Colab online note book.
2. You can use Numpy to handle matrices.
3. To visualize the output you can use Seaborn and Matplotlib