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Subject: Target Radar using Non-Doppler Processing

This document describes the MATLAB processing steps to estimate targets without Doppler processing. These processing steps will eventually be programmed directly onto the AWR1642 chip.

The document has the following structure. First, a profile configuration is defined for the mmWave Demo Visualizer. Second, the same profile configuration is programmed for the mmWave Studio using the DCA 1000 data acquisition board. Data is collected from both the Demo Visualizer and from the DCA module. Last, the raw analog to digital conversion (ADC) voltages from the DCA module are processed using MATLAB to produce radar targets.

1. Demo Visualizer

A profile configuration was defined that would run on TI's mmWave Demo Visualizer software.

The profile configuration is named: profile_crw_dca_2018_1015v2.cfg.

The file description_profile_crw_dca_2018_1015v2.txt profiles some additional information about the configuration.

A couple key configurations are:

profileCfg 0 77 40 7 57.14 0 0 60 1 256 5209 0 0 30

77 GHz start frequency

40 microsecond idle time between previous ramp end to next ramp start

7 microsecond delay from ramp start time to first ADC sample

57.14 microsecond ramp time

60 MHz/microsecond ramp slope

256 ADC samples (256*(1/5.209 MHz) = 49.14 microseconds)

5.209 MHz sample rate

frameCfg 0 1 16 0 40 1 0

16 chirps per frame

40 milliseconds between frames (25 frames per second)

The Demo Visualizer software required at least 16 chirps per frame. (We will have to test this with our code, but we may not be able to transmit less than 16 chirps per frame.)

Data was collected for 10 seconds using this profile configuration.

The saved file is named: xwr16xx_crw_demo_visualizer_2018_1015v2.dat

2. DCA 1000 Module

A profile configuration was defined that mimicked the Demo Visualizer profiler configuration.

The profile configuration file name is: DataCaptureDemo_xWR.lua

A couple key configuration lines are:

ar1.ProfileConfig(0, 77, 40, 7, 57.14, 0, 0, 0, 0, 0, 0, 60, 1, 256, 5209, 0, 0, 30)

77 GHz start frequency

40 microsecond idle time between previous ramp end to next ramp start

7 microsecond delay from ramp start time to first ADC sample

57.14 microsecond ramp time

60 MHz/microsecond ramp slope

256 ADC samples (256*(1/5.209 MHz) = 49.14 microseconds)

5.209 MHz sample rate

ar1.FrameConfig(0, 1, 8, 16, 40, 0, 1)

8 frames

16 chirps per frame

40 milliseconds between frames (25 frames per second)

(Note that the order of parameters is different for Demo Visualizer and mmWave Studio.)

Data was collected using this lua file, which saved 8 consecutive frames.

The saved file is named: xwr16xx_crw_dca_module_2018_1015v2.bin

3. MATLAB code

The MATLAB code is written using 4 different sections. Part 1 defines which file to process and defines the profile configuration. Part 2 reads the raw data and reorders the voltages by (Tx, Rx) pairs. Part 3 processes a single frame and mimics the real-time processing.

Part 1. Initial Setup

This section defines the file to process and the profile configuration. Lines 7 to 70.

Part 2. Read the ADC voltages into MATLAB workspace

This section reads in the binary ADC voltages and re-arranges the order to be human readable. Lines 71 to 187.

Part 3. Process each Frame of Data (Mimic Real-Time Processing)

This section does the actual computations which are processed for each frame. For each frame, do the following computations:

A. Perform the range-FFT on each chirp
   This processing is actually done using ping-pong logic and is performed during the frame.
B. Calculate the mean power profile for each (Tx,Rx) pair
   This section calculates the mean power and the mean real and mean imaginary components.
C. Calculate the mean profile for all (Tx,Rx) pairs
   This processing is performed just for plotting purposes and will not be used in the actual xwr16xx processing.
D. Plot the range-FFT magnitudes
   This section is just for diagnostics.
E. Calculate angle-FFT for each range gate
   The angles are expressed in radians. Convert to degrees by multiplying by (180/pi).
F. Find single target in each range gate
   This finds the largest magnitude peak between -46 to +46 degrees
G. Find Three targets in each range gate
   This finds the primary peak and one peak to the left and one peak to the right
H. Plot the single and 3-targets per range gate
   This plots each target on a scatter plot using (x,y) and intensity