

TI mmWave Sensors: Get Up and Running

Industrial mmWave Applications Team

4/3/2018

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Agenda

- Introductions
- Walk through OOB (out-of-box) Demo of SDK1p1
 - Options in mmwave demo visualizer
 - Understanding configuration file options
- Feature highlights of Mmwave SDK1p1 OOB Demo
- Demo of calibration feature/dataformat
- QA

Introductions

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Presenters

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Application Engineer, Industrial mmWave Radar.

Currently works on Mmwave radar SOCs, focusing on application notes publication, customer support on Mmwave SDK and release of Mmwave training labs.
Before that, she worked on the digital front end in small cell application.

Adrian Ozer

Application Engineer, Industrial mmWave Radar

Bachelors at Texas A&M University,
Masters at the University of Texas at San Antonio.
Applications in analog logic before joining the Industrial Radar team.

About Out of box (OOB) demo

- Out-of-box demo with easy configurability via TI cloud based GUI
- The demonstration assumes that mmwave SDK has been installed and binaries are flashed
- IWR1443BOOST EVM will be used as an example for the OOB demo walkthrough

Walk Through of OOB Demo

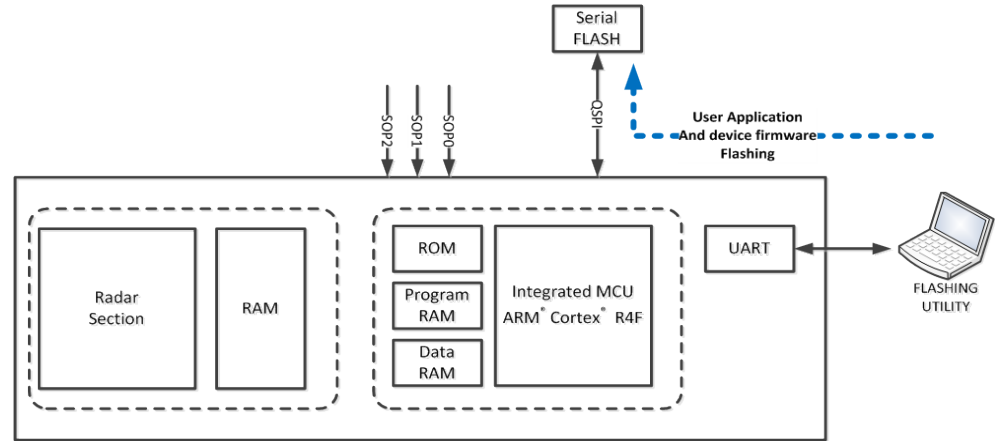
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Setup of OOB Demo

- Hardware connection
 - Power (5V)
 - USB connection

- After the binaries are flashed on to EVM, put the SOP pin on the functional mode and then power up



- Go to mmwave demo visualizer at
 - https://dev.ti.com/gallery/view/mmwave/mmWave_Demo_Visualizer/
 - Or search mmwave demo at <https://dev.ti.com/gallery>. Visualizer can be downloaded for off-line usage as well.

Switch to Visualizer

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New Features of OOB Demo (SDK1.1)


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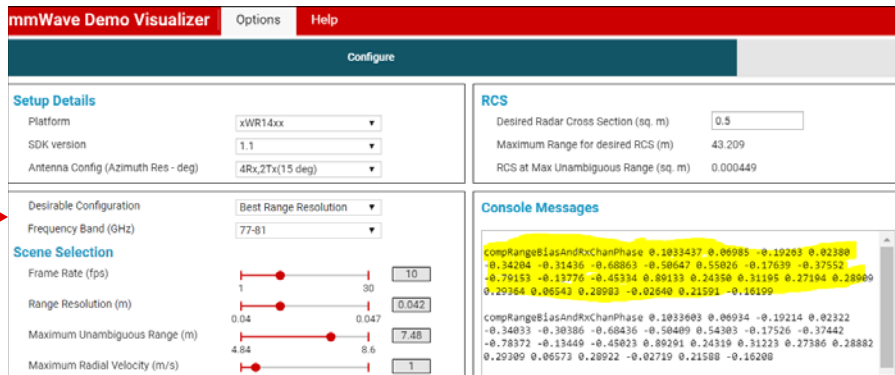
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New Features and Demo

- Added support for advanced frame config in mmW demo for xWR16xx(will not show)
- Added Static clutter removal command – the mean value of the input samples to the 2D-FFT are subtracted (already demoed)
- Added new procedure and command in mmW demo to enable user to measure and compensate for range bias and rx antenna gain and phase error (will be demoed next)

Range Bias and Rx Channel Gain/Phase Measurement and Compensation

- Place a strong target at distance X ($> 50\text{cm}$)
- Use the included `profile_calibration.cfg`, set command:
 - `measureRangeBiasAndRxChanPhase 1 X D`
 - D is the distance of a few range bins
- Start the sensor with the configuration file
- The measurement results are written out on the CLI port 
- The command printed out on the CLI now can be copied and pasted in any configuration file for correction purposes



The screenshot displays the mmWave Demo Visualizer interface. The top navigation bar includes 'mmWave Demo Visualizer', 'Options', and 'Help'. Below this is a 'Configure' tab. The interface is divided into several sections:

- Setup Details:** Platform (xWR14xx), SDK version (1.1), and Antenna Config (4Rx,2Tx(15 deg)).
- Desirable Configuration:** Best Range Resolution and Frequency Band (77-81).
- Scene Selection:** Frame Rate (fps) set to 10, Range Resolution (m) set to 0.042, Maximum Unambiguous Range (m) set to 7.48, and Maximum Radial Velocity (m/s) set to 1.
- RCS:** Desired Radar Cross Section (sq. m) set to 0.5, Maximum Range for desired RCS (m) set to 43.209, and RCS at Max Unambiguous Range (sq. m) set to 0.000449.
- Console Messages:** A scrollable area showing the output of the `measureRangeBiasAndRxChanPhase` command. The output is a list of 10 range bins, each with four values representing range bias and Rx channel gain/phase. The first bin is highlighted in yellow.

```
CompRangeBiasAndRxChanPhase 0.1893437 0.06985 -0.19263 0.02388  
-0.34284 -0.31436 -0.68863 0.58647 0.55026 -0.17639 -0.37552  
-0.79153 -0.13776 -0.45334 0.89133 0.24598 0.31195 0.27184 0.28649  
0.29964 0.06542 0.28993 -0.02640 0.21591 -0.16109  
CompRangeBiasAndRxChanPhase 0.1893683 0.06994 -0.19214 0.02322  
-0.34893 -0.36386 -0.68436 -0.50489 0.54383 -0.17526 -0.37442  
-0.78372 -0.13449 -0.45823 0.89291 0.24319 0.31223 0.27386 0.28882  
0.29209 0.06573 0.28922 -0.02719 0.21598 -0.16208
```

Range Bias and Rx Channel Gain/Phase Measurement and Compensation

- The range bias and RX channel gain offset will compensate for the inherent offset due to signal chain processing delays and board delays
- The phase measurement offset compensates for the phase delay between receivers to give a linear phase response between receivers
- `compRangeBiasAndRxChanPhase` `<rangeBias>` `<Re(0,0)>`
`<Im(0,0)>` `<Re(0,1)>` `<Im(0,1)>` ... `<Re(0,R-1)>` `<Im(0,R-1)>`
`<Re(1,0)>` `<Im(1,0)>` ... `<Re(T-1,R-1)>` `<Im(T-1,R-1)>`

Useful Links

- Mmwave demo visualizer
 - https://dev.ti.com/gallery/view/mmwave/mmWave_Demo_Visualizer/
 - Or search mmwave demo at <https://dev.ti.com/gallery>. Visualizer can be downloaded for off-line usage as well.
 - [Mmwave demo visualizer user guide](#)
- Mmwave SDK: <http://www.ti.com/tool/mmwave-sdk>
 - SDK user guide is located under SDK_Install_DIR/docs
- Chirp design tool: [Mmwave Sensing Estimator](#)

Backups/Deleted

Demo in Visualizer (placeholder)

- Online Visualizer link (include download location),
- help menu showing the user guide link,
- show the uart ports
- Reset EVM, will show in the console the EVM platform/SDK version
- Introduce the two tabs of visualizer

Mmwave Demo Visualizer (placeholder)

- Two tabs – Configure and Plots
 - Plots enables user to load existing configuration files
 - Configure provides more flexibility
 - Either case, the CLI commands are shown in the Configure tab console messages, and all plots are in Plots tab
- Configure Tab
 - Scene Selection/Object Detection/Plot selection options
 - Configurations can be saved
- Plots Tab
 - X-Y scatter plot, 3D plot, Range Profile, Doppler-Range plots....
 - Display parameters selection

The effect on configuration

- **Antenna Config** – corresponds to **channelCfg** setting (note, requires a reset of board for this change)
- **Desirable Configuration** – gives pre-optimized cfgs
- **Frequency Band** – directly affect range resolution and **profileCfg**
- **Frame Rate** – corresponds to the **frameCfg** parameter
- The rest of **Scene Selection** gauges will affect the **profileCfg**
 - Scene Selection/Object Detection/Plot selection options
 - Configurations can be saved
- **Plot selection** corresponds to **guiMonitor** command
- Mention of clutterRemoval and cfarCfg (will demo later)

Plots tab

- Load cfg button
- Sensor Start, will change to Sensor Stop when click
- Talk about display parameters in following sequence:
 - Chirp/frame
 - Scene
 - Profiling

Plots tab (cont)

- Talk about the X-Y plots and range plots.
 - Dots correlation – all for detected objects
 - Noise profile vs range profile
 - Dot location, moving object from left to right
 - Show the zoom-in/pan feature of the plots
- Doppler map, dots also corresponds to the object, doing a hand gesture showing positive value when moving away and vice versa
- Demonstrate Cfar threshold setting and clutter removal effect

Plots tab (cont)

- Select Range Azimuth Heat Map
 - Make sure to point the darkest point corresponds to the object
 - Change object angle
- Select Range Doppler Heat Map
 - Mention that two heat maps are not to be selected at the same time due to UART speed limitation
 - Make sure to point the darkest point corresponds to the object
 - Do a hand gesture again to show how the doppler heat map change

Common commands of xwr1443 and xwr1642

- dfeDataOutputMode
- channelCfg
- adcCfg
- profileCfg
- chirpCfg
- frameCf
- compRangeBiasAndRxChanPhase

Same as
SDK1.0

Added in SDK1.1: for
range bias and rx
antenna gain/phase
offset

Commands with Added parameters for xWR1642

- adcbufCfg
- guiMonitor
- cfarCfg
- peakGrouping
- calibDcRangeSig
- ClutterRemoval
- measureRangeBiasAndRxChanPhase:

- For xWR1443, the commands are the same as before.
- For xWR1642, one more parameter is added at beginning –
 - using -1 for legacy mode
 - the intended subframe number in advanced frame mode

Set of Complex value representing compensation for virtual Rx channel phase bias (12 for xWR1443 and 8 for xWR1642)