

Parameter Tuning Guide for the Intrusion Detection Demo

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Version History

Ver.	Date	By	Comment
0.1	June 2024	Muhammet Yanik	Initial version.
0.2	October 2024	Muhammet Yanik	A zone-based intruder configuration command is added.
0.3	November 2024	Muhammet Yanik	Additional features are added. The tuning parameters are updated to support the xWRL6844 demo.

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1 Introduction and Scope

This document provides a high-level overview of the signal processing chain developed for intrusion detection applications. It presents a guide for the user to tune this demo for different environments. It aims to explain the configurable processing chain parameters, which the user can tune to improve the overall demo performance. It is important to note that the scope of this document is limited to the performance tuning level. The implementation details of the processing chain, including the execution flow, memory management, etc., will be given in a separate demo implementation guide.

The processing chain shown in Figure 1 first handles reflections from the three-dimensional (3D) environment around the sensor and delivers the signal-to-noise ratio (SNR) estimations of each voxel point defined in this 3D environment. The high-level processing layer then processes the estimated SNR to give the final intrusion alert in the pre-defined scene boundaries of this 3D environment.

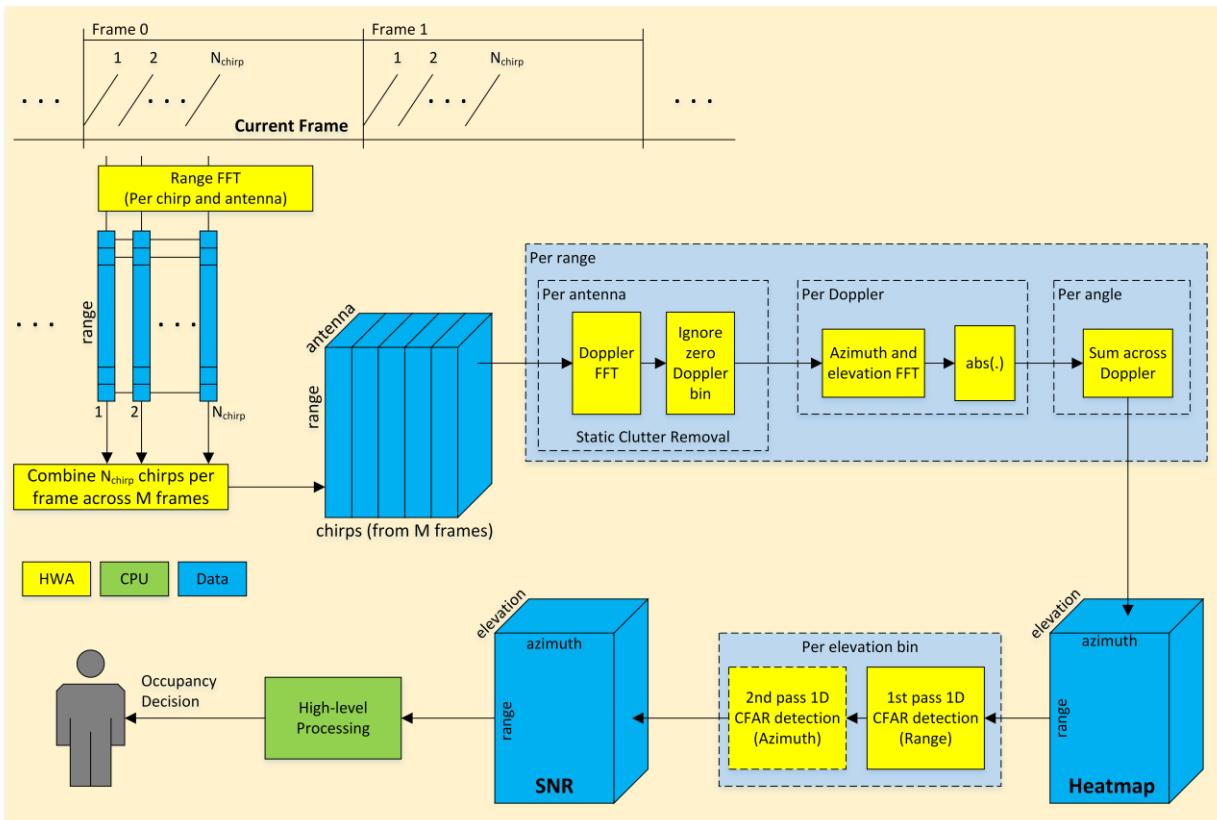


Figure 1. The overall processing chain of the intrusion detection demo.

The analog-to-digital converter (ADC) data (i.e., the beat signal) from the sensor front-end is the input of the processing chain. The 3D SNR matrix generated by the detection layer represents the SNR estimation of each reflection point in range-azimuth-elevation domains. A high-level processing layer then processes the SNR matrix to run the logic that decides whether a predefined region of interest (ROI) has an intrusion event.

In the proposed high-level processing logic, we first partition the entire scene into target and reference zones. Once we estimate the SNR information in every voxel point in the field of view (i.e., range, azimuth, and elevation), we assign this information at each point to the predefined zones (e.g., target zones) where the occupancy is expected to occur. We also define a reference zone in the same boundary region, where an occupancy state is not expected (i.e., reference zone), and assign the extracted SNR information of the corresponding voxel points to this reference zone. In an intruder detection task, the reference zone can be the central region of the vehicle, while the target zones can be defined as the boundary regions of the vehicle (e.g., windows and doors, etc.). This assignment is valid in a real-world intrusion scenario since the central region of the vehicle cannot be occupied before the boundary regions; hence, the central region can be used as a reference non-occupied zone. Therefore, the processing chain can detect an intrusion when the reference zone is not occupied as planned, and the intrusion happens through the vehicle boundary. As shown in Figure 2, a typical car boundary can be divided into six zones: (1)(2) Dashboards, (3)(4) 1st Rows, (5)(6) 2nd Rows.

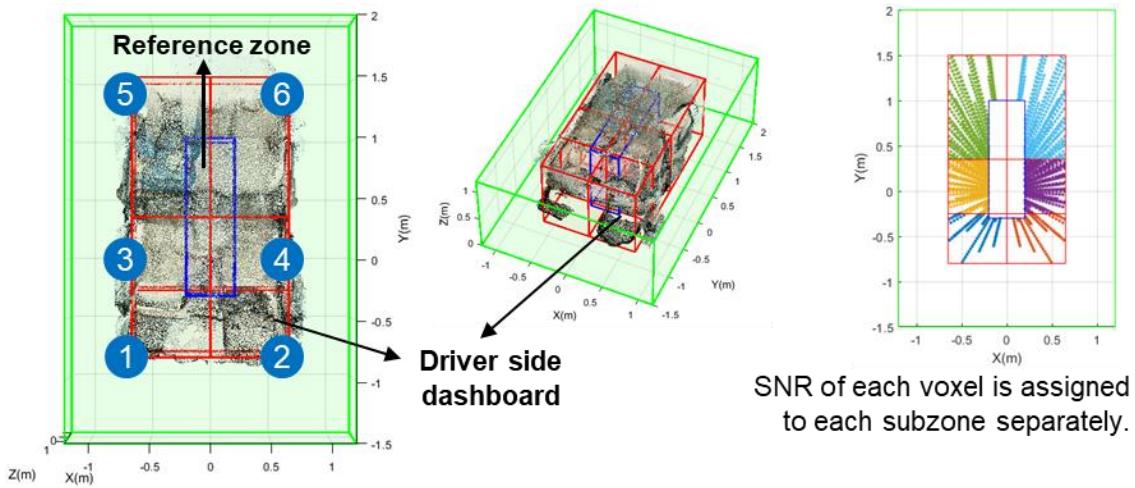


Figure 2. Definitions of a typical car boundary that consists of a reference zone and multiple target zones.

As shown in Figure 3, there are some cases that may create false alarms with the basic SNR-to-zone assignment process. In this scenario, while the person is outside, the leakage of the main beam into the car boundary and also the sidelobes of the main beam create unwanted deviation (hence a false alarm) in the target zones compared to the reference zone. To address these corner cases, we also used local peak and sidelobe checks in the algorithm to avoid using such unwanted heatmap portions, as shown in Figure 4.

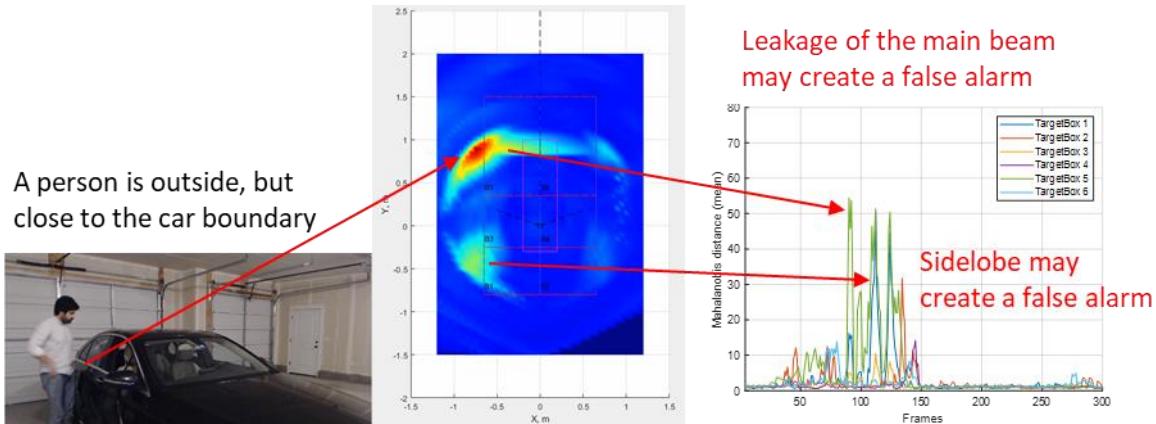


Figure 3. An example scenario that creates false alarms with the basic zone assignment step.

On the other hand, this additional filtering in the data may also reduce the detection performance of real intrusion events. To address all these false alarm mitigations by not sacrificing the detection performance, a peak expansion approach around the extracted local peak is used, as illustrated in Figure 4. Enabling the local peak check, configuring the sidelobe threshold in the sidelobe check, and also configuring the number of samples expanded around the local peaks can all be configured by the user, as discussed in Section 2.

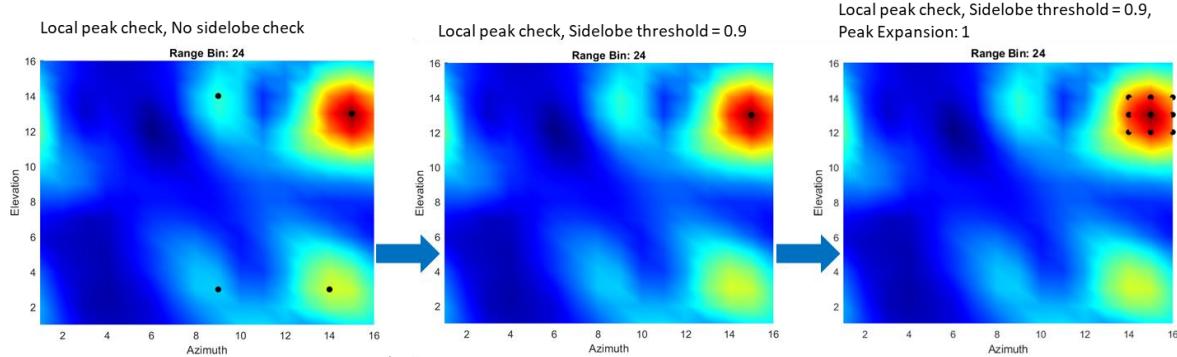


Figure 4. Local peak check, sidelobe check, and peak expansion in the processing chain.

2 Configuration Parameters

The parameters presented in this section are used to configure the intrusion detection demo and can be adjusted to match the use cases based on the particular scenery characteristics. The user can set the configuration parameters using the configuration (i.e., cfg) files in the demo application folders. An example configuration file is given in Table 1. Each line in these files represents a CLI message that configures several parameters. It is important to note that Table 1 may not have the correct sequence of the commands that the demo requires. Besides, there may be some other commands in the cfg files that are not listed in these tables. For the complete command set and the correct sequence, please refer to the cfg files in the demo application folders and the SDK documents [1].

Table 1. The commands in an example configuration (cfg) file for the demo.

No	Parameter group	CLI commands and arguments
1	Sensor front-end parameters	<pre>sensorStop 0 channelCfg 15 15 0 chirpComnCfg 80 0 0 128 1 63 0 chirpTimingCfg 7 24 0 60 57 frameCfg 16 0 1400 1 100 0 sensorStart 0 0 0 0</pre>
2	Detection layer parameters	<pre>runningMode 0 sigProcChainCfg 16 16 2 sigProcChainCommonCfg 4 cfarCfg 2 8 4 3 0 cfarScndPassCfg 1 2 4 3 2 1 clutterRemoval 1 antGeometryCfg 0 2 1 2 1 3 0 3 0 0 1 0 1 1 0 1 2 0 3 0 3 1 2 1 2 2 3 2 3 3 2 3 compRangeBiasAndRxChanPhase 0.0 -10 -10 -10 -10 1 0 1 0 1 0 1 0 -10 -10 -10 -10 1 0 1 0 1 0 1 0 guiMonitor 0 0 0 1 0 0</pre>
4	High-level processing parameters	<pre>sensorPosition 0 0 1 0 -60 occupancyBox 0 -0.20 0.20 -0.30 1.00 0.00 1.05 occupancyBox 1 -0.55 0.00 -0.80 -0.25 0.00 1.05 occupancyBox 2 0.00 0.55 -0.80 -0.25 0.00 1.05 occupancyBox 3 -0.55 0.00 -0.25 0.35 0.00 1.05 occupancyBox 4 0.00 0.55 -0.25 0.35 0.00 1.05 occupancyBox 5 -0.55 0.00 0.35 1.50 0.00 1.05 occupancyBox 6 0.00 0.55 0.35 1.50 0.00 1.05 intruderDetCfg 12 2 10 2 0.9 2</pre>

This document elaborates specifically on the supported configuration parameters in the intrusion detection demo. The remaining parameters (and the configuration options they provide) that are not detailed in this document (especially at the sensor front-end level) can be found in the SDK documentation [1]. It is important to emphasize that we recommend using the provided values of the configuration parameters as the best empirical values we obtained from testing in different environments.

2.1 Sensor Front-End Parameters

The sensor front-end parameters configure the intrusion detection demo at the frequency-modulated continuous wave (FMCW) signal level. To get a general understanding of the sensor front-end parameters, please refer to the SDK [1]. The example configuration file proposed in this demo uses a high-BW chirp configuration with four chirps per TX (real-only baseband) in Time-Division Multiplexing (TDM) mode, as summarized in Table 2.

Table 2. The chirp configuration proposed in the example configuration (cfg) file.

Chirp Parameters and System Performance:	Unit	Value
Starting frequency	GHz	57.0
Ramp slope	(MHz/ μ s)	60.0
Number of samples per chirp	-	128
Number of chirp loops per TX	-	4
Sampling frequency	Msps	2.5
Idle time (for all TXs)	μ s	7
ADC start time	μ s	9.6
Excess ramping time	μ s	2.2
Chirp time, Tc	μ s	51.2
Ramp end time	μ s	63.0
Valid sweep bandwidth, B	MHz	3072
Total sweep bandwidth, B	MHz	3780
Frame period	ms	100
Maximum range	m	2.5
Range resolution	cm	4.88

2.2 Detection Layer Parameters

In the following subsections, the detection layer configuration parameters summarized in Table 1 are detailed. Each table in this section presents the data type and description of each parameter along with the suggested values in an example scenario. Recall that the data types are only classified as ‘int’ for integer numbers and ‘float’ for floating-point numbers. This document does not cover the actual byte size of the parameters (uint8, int32, etc.). Instead, the supported values or valid ranges in each parameter are

given in the corresponding section. For more details about the actual data size, please refer to the implementation's source code.

2.2.1 Processing Chain Configuration

The following command configures the demo to run the intrusion detection application.

runningMode 0			
Parameter	Type	Value	Description
runningMode	int	0	<p>Set to 0 to run the intrusion detection application. All the supported modes are:</p> <ul style="list-style-type: none"> ▪ 0: Intrusion detection ▪ 1: Seat belt reminder (SBR) ▪ 2: Child presence detection (CPD) <p>The tuning parameters of the SBR and CPD applications are detailed in a separate document.</p>

The following command configures the parameters of the detection layer processing chain in Table 1.

sigProcChainCfg 16 16 2			
Parameter	Type	Value	Description
azimuthFftSize	int	16	Azimuth FFT size. Set as power of 2 . Refer to the note below ¹ for the details.
elevationFftSize	int	16	Elevation FFT size. Set as power of 2 . Refer to the note below ¹ for the details.
coherentDoppler	int	2	Set to 2 .

¹azimuthFftSize and elevationFftSize: These parameters define the azimuth and elevation FFT sizes in the angle estimation steps. Both parameters, which affect the search granularity (i.e., the inter-bin resolution) in the angle domain, have a significant impact on the processing load (also affects the power consumption). Hence, both parameters should be carefully optimized for the desired use case. Depending on the use case restrictions (power consumption, frame rate, etc.), small azimuth and elevation FFT sizes may be required. This will create coarse angle steps in the azimuth-elevation grid.

As illustrated in Figure 1, the signal processing chain can work both with major processing and minor processing modes. If a major processing mode is selected, only the chirps available within the given frame will be used in the processing chain. If the minor processing mode is selected, the chirps across multiple frames will be combined in the chain to achieve a better velocity resolution. Depending on the processing mode selected, only a single SNR matrix is provided to the high-level processing block. The following command configures the number of frames used in the processing chain. In this command, configuring 1 means using a single frame (i.e., major mode), and configuring N (>1) means using N number of frames (i.e., minor mode). It is suggested that minor motion modes be set to create enough velocity resolution with a limited number of chirps per frame (to save power).

sigProcChainCommonCfg 4			
Parameter	Type	Value	Description
numFrmPerSlidingWindow	int	4	Number of frames included for minor motion detection. Refer to the note below ¹ for the details.

¹**numFrmPerSlidingWindow:** The detection layer chain utilizes the combined chirp blocks from the current and previous frames to increase the chirping window for minor and very fine motions. This parameter defines the number of frames included for minor motion detection mode (1 means major mode with a single frame). These parameters are closely related to the number of chirps available in a single frame and the total retention time desired to detect minor motions. In this mode, all the available chirps defined in the `frameCfg` command will be concatenated to generate the total chirp block across frames. Besides, when configuring these parameters, the frame rate should also be considered. Finally, the total number of chirps in the chirp block created across multiple frames must be a power of 2.

2.2.2 CFAR Configuration

In the processing chain, the two-pass CFAR algorithm is applied directly to the generated 3D range-azimuth-elevation heatmap. In this two-pass CFAR algorithm, the first-pass scanning on each angle bin runs the 1D-CFAR logic to estimate noise across the range bins. The commands needed for the first-pass CFAR are given in the table below.

cfarCfg 2 8 4 3 0			
Parameter	Type	Value	Description
averageMode	int	2	CFAR averaging mode selection: 0: CFAR-CA. 1: CFAR-CAGO. 2: CFAR-CASO. Suggested to set 2.
winLen	int	8	One-sided noise averaging window length (in samples) of range-CFAR. Suggested to set as power of 2.
guardLen	int	4	One-sided guard length (in samples) of range-CFAR.
noiseDiv	int	3	Cumulative noise sum divisor expressed as a shift. Sum of noise samples is divided by 2^{noiseDiv} . Should be set as log2(winLen).
cyclicMode	int	0	Cyclic mode or wrapped around mode: 0: Disabled. 1: Enabled. Suggested to disable in range-domain CFAR.

In the processing chain, the second-pass CFAR is optional. When enabled, the second-pass scanning on each range bin runs the CFAR logic to estimate noise across the angle bins. After the second-pass CFAR, the overall noise is then estimated by the average of the noise estimations from the first and second

passes. The commands needed for the second-pass CFAR are given in the table below. It is important to note that the second-pass CFAR runs across azimuth bins. Since the input heatmap is 3D in range-azimuth-elevation domains, the two-pass CFAR logic runs per elevation bin separately.

cfarScndPassCfg 1 2 4 3 2 1			
Parameter	Type	Value	Description
enabled	int	1	Enable/disable the second pass CFAR: 0: Disabled. 1: Enabled.
averageMode	int	2	CFAR averaging mode selection: 0: CFAR-CA. 1: CFAR-CAGO. 2: CFAR-CASO. Suggested to set 2.
winLen	int	4	One-sided noise averaging window length (in samples) of angle-CFAR. Suggested to set as power of 2.
guardLen	int	3	One-sided guard length (in samples) of angle-CFAR.
noiseDiv	int	2	Cumulative noise sum divisor expressed as a shift. Sum of noise samples is divided by 2^{noiseDiv} . Should be set as log2(winLen).
cyclicMode	int	1	Cyclic mode or wrapped around mode: 0: Disabled. 1: Enabled. Suggested to enable in angle-domain CFAR.

The following parameter configures the HWA CFAR engine to decide the version of the CFAR-CA method performed in either range or azimuth domains.

averageMode: This field configures the mode of the CFAR method in any of the following options:

- CFAR CA (cell averaging): The average of both left and right reference windows is used as noise estimation for CFAR detection.
- CFAR CAGO (cell averaging with greater of selection): The greater average of the left and right reference windows are used as noise estimation for the CFAR detection.
- CFAR CASO (cell averaging with smaller of selection): The smaller average of the left and right reference windows is used as noise estimation for the CFAR detection.

The following CFAR window parameters are used to configure the HWA CFAR engine and define a sliding window to calculate the local noise floor to be compared with the cell under test (CUT).

winLen: This field is the CFAR reference window length (in terms of the number of samples) for CFARs.

guardLen: This field is the CFAR guard window size (in terms of the number of samples). When calculating the noise estimation, the left and right **guardLen** of samples will be excluded from noise accumulation.

For example, if we have a target with an area of 0.5m^2 reflecting radar energy, we do not want samples in those areas being counted as noise samples to raise the detection threshold. The user should adjust the setting based on the chirp configuration and derived inter-bin resolution, as well as the typical target size within the scene.

noiseDiv: This parameter specifies the division factor with which the noise sum calculated from the left and right noise windows are divided in order to get the final surrounding noise average value. The division factor is equal to 2^{noiseDiv} . Therefore, only powers-of-2 division is possible, even though the number of samples specified in `winLen` is not restricted to powers of 2.

cyclicMode: This parameter specifies whether the CFAR-CA detector needs to work in cyclic mode or in non-cyclic mode. When this field is 0, the CFAR detector works in non-cyclic mode, and when it is 1, it works in cyclic mode. These two modes are different in the way the samples at the edges are handled. In cyclic mode, the CFAR-CA detector needs to wrap around the edges in a circular manner.

2.2.3 Clutter Removal Configuration

The following parameter enables/disables the clutter removal step. Because the main goal of the intrusion detection chain is to detect motions in the scene, this parameter must always be set to 1. This parameter is included in the cfg file for debugging or when analyzing the reflections from the static scenes.

clutterRemoval 1			
Parameter	Type	Value	Description
enabled	int	1	Configure static clutter removal: 0: Disabled. 1: Enabled. Always set to 1 if it is desired to detect moving objects only (person, etc.) in the scene.

2.2.4 Antenna Pattern Configuration

The intrusion detection demo can support different antenna configurations. Although the default parameters of the demo are configured according to the xWRL6844 EVM [2], the user can change the layout using the following command. In this command, the row and column index of each antenna define the virtual antennas' physical location index (0, 1, 2, ...) in the elevation and azimuth domains, respectively. In other words, for the xWRL6844 EVM antenna pattern shown in Figure 5, these index values indicate four elevation rows (specified by 0, 1, 2, 3), and four azimuth columns (specified by 0, 1, 2, 3) on each elevation row.

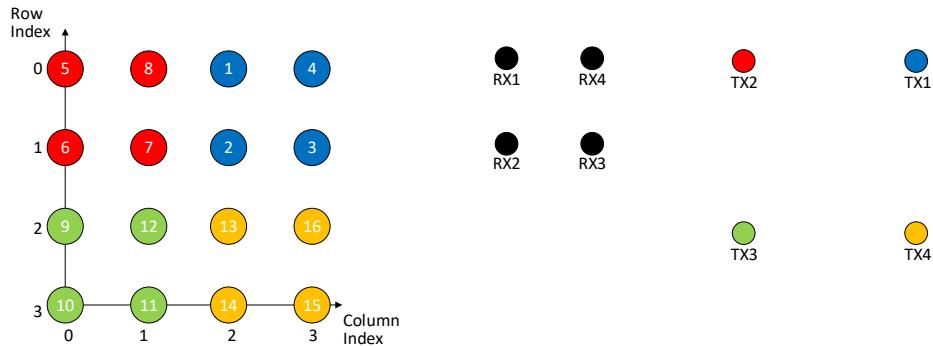


Figure 5. The antenna pattern of the xWRL6844 EVM and the corresponding index values.

antGeometryCfg 0 2 1 2 1 3 0 3 0 0 1 0 1 1 0 1 2 0 3 0 3 1 2 1 2 2 3 2 3 3 2 3 2.540 2.540			
Parameter	Type	Value	Description
ant1IdxRow	int	0	Row index of virtual antenna 1 (TxAnt1->RxAnt1).
ant1IdxCol	int	2	Column index of virtual antenna 1 (TxAnt1->RxAnt1).
ant2IdxRow	int	1	Row index of virtual antenna 2 (TxAnt1->RxAnt2).
ant2IdxCol	int	2	Column index of virtual antenna 2 (TxAnt1->RxAnt2).
...
ant16IdxRow	int	2	Row index of virtual antenna 16 (TxAnt4->RxAnt4).
ant16IdxCol	int	3	Column index of virtual antenna 16 (TxAnt4->RxAnt4).
antDistCol	float	2.540	Antenna spacing in X dimension (i.e., between azimuth columns) in mm. This is an optional argument. If omitted, it is assumed that $d = \lambda/2$, where λ (wavelength) is computed based on the center frequency of the chirp configuration. It is assumed that the azimuth columns are uniformly distributed. <i>The value given here (2.540mm) is the antenna spacing for wWRL6844 EVM [2].</i>
antDistRow	float	2.540	Antenna spacing in Z dimension (i.e., between elevation rows) in mm. This is an optional argument. If omitted, it is assumed that $d = \lambda/2$, where λ (wavelength) is computed based on the center frequency of the chirp configuration. It is assumed that the elevation rows are uniformly distributed. <i>The value given here (2.540mm) is the antenna spacing for wWRL6844 EVM [2].</i>

2.2.5 Range Bias and Phase Compensation Configuration

This set of range and phase compensation parameters can be derived using a corner reflector at sensor boresight (at about a few meters). If the user decides not to compensate for the bias, the default values in the following table can be set in the configuration file.

compRangeBiasAndRxChanPhase 0.0 -1 0 -1 0 -1 0 -1 0 1 0 1 0 1 0 1 0 -1 0 -1 0 -1 0 -1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0			
Parameter	Type	Value	Description
rangeBias	float	0.0	Range bias common for all antennas.
ant1PhaseReal	float	-1	Phase compensation factor (real) of the 1st virtual antenna.
ant1PhaselMag	float	0	Phase compensation factor (imaginary) of the 1st virtual antenna.
ant2PhaseReal	float	-1	Phase compensation factor (real) of the 2nd virtual antenna.
ant2PhaselMag	float	0	Phase compensation factor (imaginary) of the 2nd virtual antenna.
...
ant16PhaseReal	float	1	Phase compensation factor (real) of the 16th virtual antenna.
ant16PhaselMag	float	0	Phase compensation factor (imaginary) of the 16th virtual antenna.

It is also important to note that if the sensor is not calibrated and the default calibration coefficients are used in the cfg file, the phase rotations at each transceiver should also be considered. Since some of the antenna elements of the xWRL6844 are fed from the opposite direction, the phase rotations for those virtual elements are set to -1. It is recommended to calibrate the sensor using a corner reflector as discussed in SDK [1].

2.2.6 GUI Monitoring Configuration

The following command configures the output data of the intrusion detection demo streamed over the UART port.

guiMonitor 0 0 0 0 1 0 0			
Parameter	Type	Value	Description
pointCloud	int	0	Not applicable for intrusion demo. Set to 0 .
rangeProfile	int	0	Range profile data transmission enable/disable flag: 0: Disable. 1: Enable range profile from major mode Refer to the note below ¹ for the details.
statsInfo	int	0	Statistics information (processing time, etc.) transmission enable/disable flag: 0: Disable. 1: Enable. Refer to the note below ² for the details.
temperatureInfo	int	0	Set to 0 .
intrusionDetInfo	int	1	Intrusion detection results enable/disable flag: 0: Disable. 1: Enable. Refer to the note below ³ for the details.
occFeatures	int	0	Not applicable for intrusion demo. Set to 0 .
occClassRes	int	0	Not applicable for intrusion demo. Set to 0 .

¹rangeProfile: This parameter enables/disables the export of range profile (at the azimuth-elevation peaks of the range-azimuth-elevation heatmap). Enabling these outputs impacts the throughput. Hence, these parameters should be enabled only in the debug mode.

²statsInfo: This parameter enables or disables the export of statistical information about the implementation, such as processing time and the UART transmission time. Both information can be used for benchmarking and performance tuning.

³intrusionDetInfo: When this flag is enabled, the device will send intrusion detection results to the host over the UART interface. The processing chain uses a cuboid-based zone mapping approach when running the high-level logic. Therefore, enabling this flag will send the binary intrusion decision (i.e., 0 or 1) for each zone to the host.

2.3 High-Level Processing Parameters

The configuration parameters presented in this section are used to configure the high-level processing layer for the intrusion decision chain. These parameters should be adjusted to match the use cases based on the particular scenery characteristics.

2.3.1 Scene Configuration

This set of parameters allows the user to configure the dimensions of the physical space in which the demo chain will operate. These also specify the radar sensor orientation and position. It's convenient to first define mathematical spaces in which the measured data is obtained, the processing chain operates, and the output is visualized. We define the following spaces which are applicable in any sensor mount configurations:

- World Space W: $\{X_w, Y_w, Z_w\}$ is Cartesian with origin at floor level of a typical car scene
- Sensor Cartesian Space T: $\{X_t, Y_t, Z_t\}$ is Cartesian with origin at the sensor
- Sensor Spherical Space P: $\{r, \varphi, \theta\}$ is Spherical with origin at the sensor. r is the radial distance, φ is the azimuth angle, and θ the elevation angle with respect to the sensor axis.

The sensor mounting geometry and its relation to the different measurement spaces are defined as:

- Sensor location $S_w = \{x_o, y_o, z_o\}$ is specified in the world Cartesian space where x_o, y_o , and z_o are the offsets of the sensor referenced to the origin (O).
- All configuration boxes defined by the user are also in the world Cartesian space. The boundary box is specified by the coordinate values $\{x_1, x_2, y_1, y_2, z_1, z_2\}$.

The following boundary box command allows the user to configure the physical dimensions of the space in which the intrusion decision will be provided. As discussed in Section 1, the intrusion decision logic can be run in multiple zones within the entire scene. Hence, multiple boundary boxes can be configured. Therefore, the entire scene can be divided into multiple boundary boxes, and each boundary box can be

sent to the device separately. This scheme will then allow running the decision logic per zone. Note that each box should be defined in meters in the world coordinates in Cartesian space.

occupancyBox 0 -0.20 0.20 -0.30 1.00 0.00 1.05			
Parameter	Type	Value	Description
index	int	0	Index of the boundary box. It should start from 0 and increase sequentially if multiple boundary boxes are defined. The first occupancy box (index 0) must always be the reference zone described in Section 1. Hence, the algorithm needs at least two occupancy boxes (one for reference and one for target region).
xMin	float	-0.20	Minimum horizontal distance (in meters) with respect to the origin in the world coordinates.
xMax	float	0.20	Maximum horizontal distance (in meters) with respect to the origin in the world coordinates.
yMin	float	-0.30	Minimum vertical (i.e., depth) distance (in meters) with respect to the origin in the world coordinates.
yMax	float	1.00	Maximum vertical (i.e., depth) distance (in meters) with respect to the origin in the world coordinates.
zMin	float	0.00	Minimum height (in meters) with respect to the origin in the world coordinates. Note that z = 0 corresponds to the ground plane.
zMax	float	1.05	Maximum height (in meters) with respect to the origin in the world coordinates.

The following command can be used to specify the radar sensor orientation and position. The sensor location $S_w = \{xOffset, yOffset, zOffset\}$ is specified in the world Cartesian space referenced to the boundary box origin.

sensorPosition 0 0 1 0 -60			
Parameter	Type	Value	Description
xOffset	float	0	Offset of the radar sensor position in x-axis referenced to the boundary box origin.
yOffset	float	0	Offset of the radar sensor position in y-axis referenced to the boundary box origin.
zOffset	float	1	Height of the radar sensor above the ground plane.
azimuthTilt	float	0	The azimuth tilt (in degrees) of the sensor about the axis Z_w .
elevationTilt	float	-60	The elevation tilt of the sensor about the axis X_w . A negative value indicates tilting towards the ground from the vertical axis.

2.3.2 State Transition Configuration

Any zone configured can be in one of two states i.e., EMPTY or INTRUSION. The transition from one state to another is determined by various parameters configured by the following command. This command will configure the decision logic for every occupancy box with common parameters.

intruderDetCfg 12 2 10 2 0.9 2			
Parameter	Type	Value	Description
threshold	float	6	The occupancy signal needed in a zone to enter the INTRUSION state. If the computed occupancy signal exceeds this threshold, the algorithm will decide if an intrusion event occurs.
free2ActiveThre	int	2	In EMPTY state; threshold for the number of continuous HIT events (in terms of number of frames) to transition from EMPTY to INTRUSION state.
active2FreeThre	int	10	In INTRUSION state; threshold for the number of consecutive MISS events (in terms of number of frames) needed to transition from INTRUSION to EMPTY state.
localPeakCheck	int	2	Local peak check enable/disable flag: 0: Disable. 2: Enable. Refer to the Section 1 for the details.
sideLobeThre	int	0.9	Sidelobe threshold in the linear scale to declare a local peak as the detected point (compared to the maximum local peak at the same range bin). Refer to the Section 1 for the details. This parameter will be used only if the localPeakCheck is enabled.
peakExpSamples	int	2	Number of samples on each side to expand the peak of the azimuth-elevation heatmap. Refer to the Section 1 for the details. This parameter will be used only if the localPeakCheck is enabled.

In the current demo, another version of this command has also been added to configure each occupancy box separately. As seen in the following [intruderDetAdvCfg](#), the index of the boundary box is added to the parameters of the [intruderDetCfg](#) command. Note that the index in this command should match with the index defined in [occupancyBox](#) command. If the user wants to use this command to configure each zone separately instead of using a common [intruderDetCfg](#) command, they should configure multiple of this command for each occupancy box separately except for the reference zone (index 0).

intruderDetAdvCfg 1 8 2 10 2 0.9 2			
Parameter	Type	Value	Description
index	int	1	Index of the boundary box. It should start from 1 and increase sequentially if multiple boundary boxes are defined. Since the first occupancy box (index 0) is always the reference zone described in Section 1, the user does not need to configure this parameter for this reference zone.
threshold	float	6	These are the same parameters detailed in the intruderDetCfg .
free2ActiveThre	int	2	Note that each of these parameters will configure each zone separately.
active2FreeThre	int	10	
localPeakCheck	int	2	
sideLobeThre	int	0.9	
peakExpSamples	int	2	

3 References

- [1] MMWAVE-L-SDK: The mmWave low-power software development kit (SDK) for xWRL6844. [Online]. Available: <https://www.ti.com/tool/MMWAVE-L-SDK>
- [2] xWRL6844 evaluation module for low-power single-chip 60GHz mmWave sensor, Texas Instruments. [Online]. Available: <https://www.ti.com/tool/TBD>