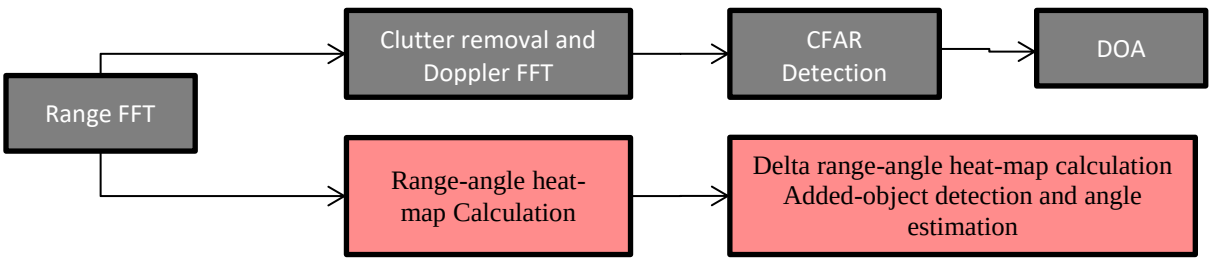
Notes on Static Object Detection

A typical goal for automatic door opening application is to reliably detect people moving towards the door. Recently, a new request is added to the application: if a person walked passed the door and dropped an object on the floor, the sensor should be able to detect that dropped object if the object is very close to the door and prevent the door from closing.

Note that the static reflection not only comes from the dropped object, it may also come from the ground, door frame, ceiling, wall and other furniture, which we call a background static scene. In order to separate the dropped object from the background scene, a calibration step is applied here: During installation stage, the background information is recorded. After that, the recorded background information will be subtracted from the current frame to detect the added scene. This background information can be captured in different format. One approach is to save the averaged range FFT output (complex value) for all antennas. This method has a very good sensitivity, but may suffer from phase change during temperature change or power restart. The approach we uses here is to record the range-angle spectrum (also referred as range-angle heat-map). The recorded spectrum is in power and therefore it is not phase sensitive.

The system block diagram is shown below. The block in pink is the added logic for added static object detection.



Two new CLI commands

1. heatmapGenCfg: it contains the parameter that controls the range-angle heat-map calculation. An example is given below:

heatmapGenCfg -1 1 0.0 10 50 60.0 3.0

New CLI command	***Parameters names***	***How to set the parameters***	
heatmapGenCfg	<subFrameIdx>	set to -1 to apply to all the subframes	
	<recordingMode>	set to 1 to start with static recording first	
	<phaseRotDeg>	set to 0 for now	
	<minRangeBin>	the minimum range bin for range-angle heat-map generation. It will affected the minimum detectable range bin to be: minRangeBin *+ 1*	

	<maxRangeBin>	the maximum range bin for range-angle heat-map generation. It will affected the maximum detectable range bin to be: *maxRangeBin - 1*	
	<maxAngleDeg>	the angle range for angle spectrum calculation will be (-maxAngleDeg:angleStepDeg:maxAngleDeg)	
	<angleStepDeg>	the step size for angle spectrum calculation. Suggested angleStepDeg value is 1~3 degrees.	

2. staticDetectionCfg: contains the parameters that controls the logic for static object detection. An example is given below:

staticDetectionCfg -1 0 -50.0 +50.0 -30.0 20.0 0.3 4.0 0.1 4

New CLI command	***Parameters names***	***Commend to set the parameters***	
staticDetectionCfg	<subFrameIdx>	set to -1 to apply to all the subframes	
	<numAngleBinToSum>	set to 0 to just use the current angle bin for comparison	
	<minAziAngleDeg>	the minimum and maximum azimuth angle in degree for detection; the object locates beyond this angle will not be detected. This is used as a filter in detection logic.	
	<maxAziAngleDeg>		
	<minEleAngleDeg>	the minimum and maximum elevation angle in degree for detection; the object locates beyond this angle will not be detected. This is used as a filter in detection logic.	
	<minEleAngleDeg>		
	<localPeakTH>	a detected peak has to be bigger than the left and right neighboring range bin (same angle) by this linear threshold It is suggested to set this parameter between 0.3~1.0 Lower this value can increase the number of detection.	
	<heatmapDiffTH>	a detected peak has to be bigger than the recording (same location) by this linear threshold. This is the most important threshold in static object detection. It is suggested to set this parameter between 4.0~6.3. Lower this value can increase the number of detection.	
	<significantTH>	a detected peak energy has to be bigger than the maximum recording by this linear threshold. It is suggested to set this parameter between 0.1~0.4 Increase this value can reduce the false detection.	
	<eAngleBinDiffTH>	The maximum elevation peak location difference between delta elevation heat-map and current heat-map. If the peak location difference is too large, it means this add-on object is not the dominant object in the range-elevation heat-map. And therefore, the estimation may not be very accurate, and the detected peak will be skipped.	

For the add-on static object to be detected, it needs to create a peak on the delta heat-map (the difference between the recorded range-azimuth heat-map and the current range-azimuth heat-map). This peak level should be significant compared to the original heat-map. At the same time, the location should be within the angle of interests in both azimuth domain and elevation domain. Note that we have seen some detected points with poor accuracy. The poor accuracy very often comes from the

elevation angle estimation. To improve that, we added the feature to skip the detection if this adds-on is not the dominant object in the range-elevation heat-map.