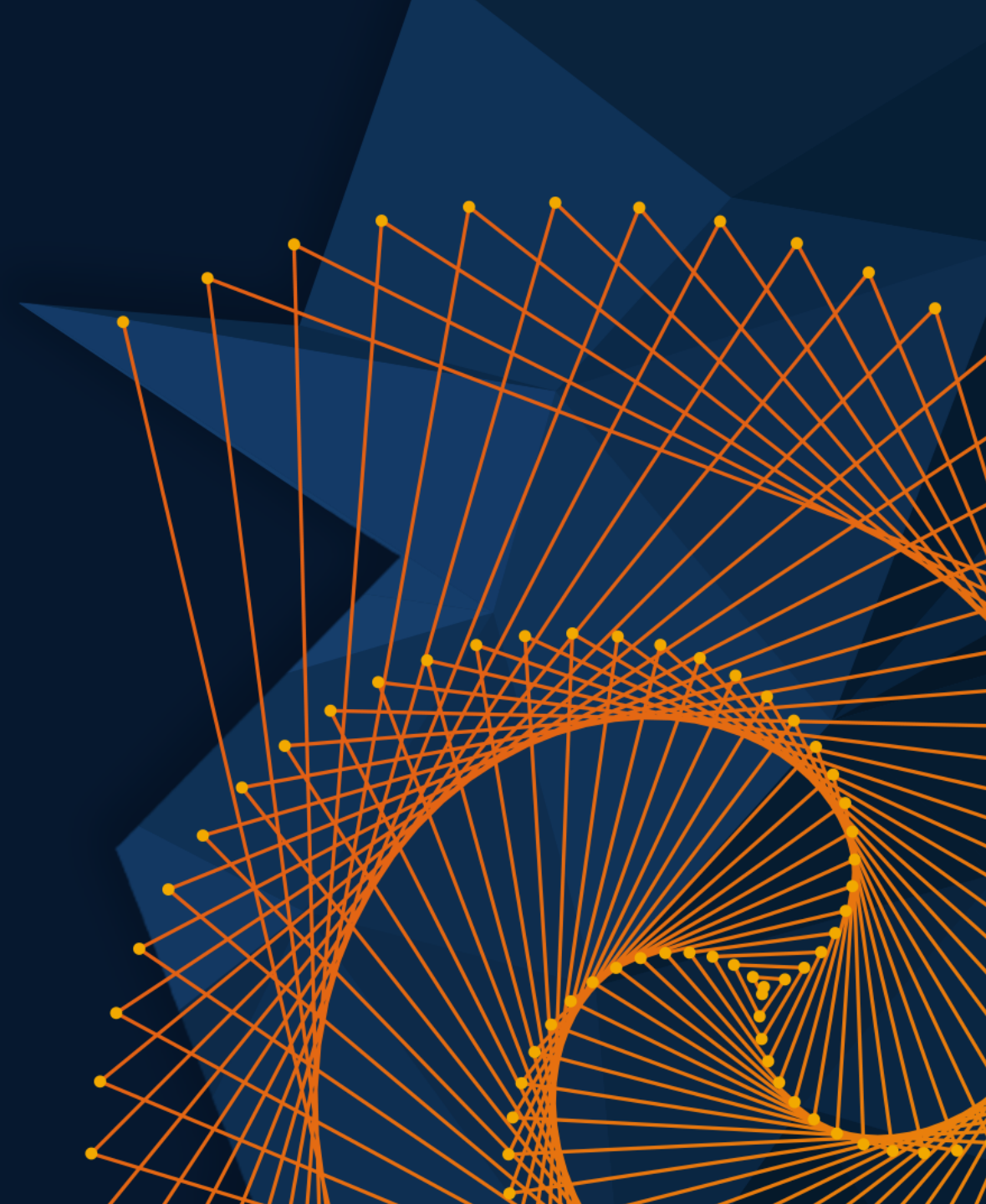


# MATLAB EXPO

## MATLAB을 활용한 TI mmWave 레이더 개발

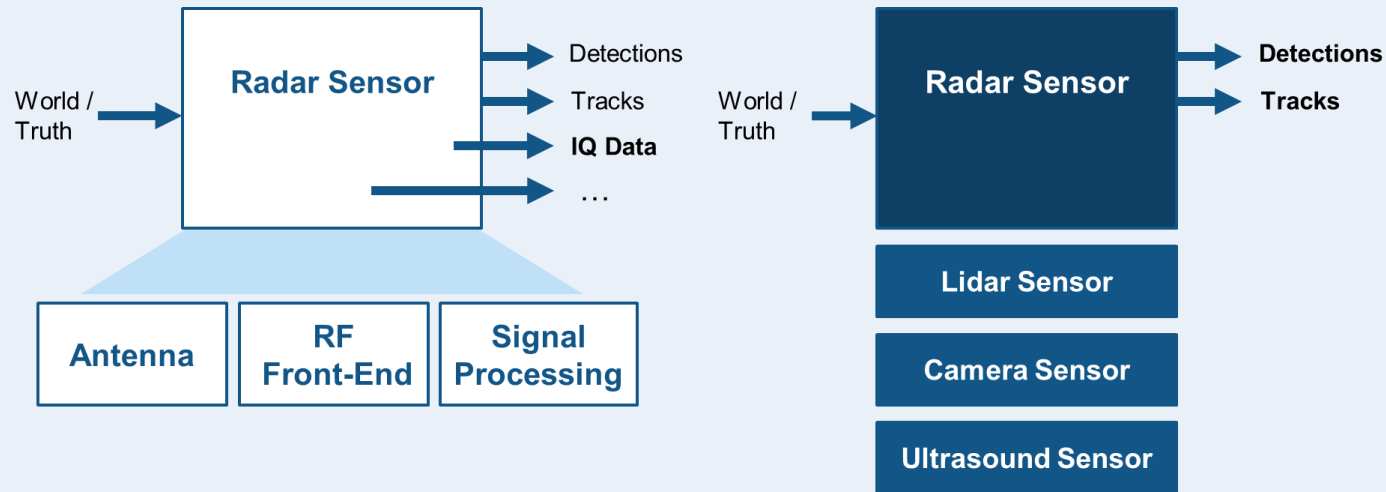
서기환, 매스웍스코리아

한승구, 매스웍스코리아

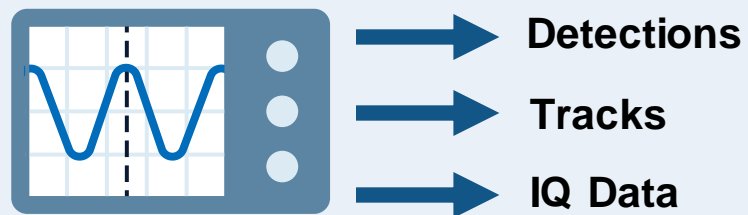


# Test and Verification of the Radar

## Radar Sensor Models



## Physical Radar Hardware



# Connect MATLAB to Hardware

- Live Data Streaming to and from Hardware
- Generating Code and Targeting Hardware

mathworks.com/hardware-support/home.html

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Trial software Contact sales

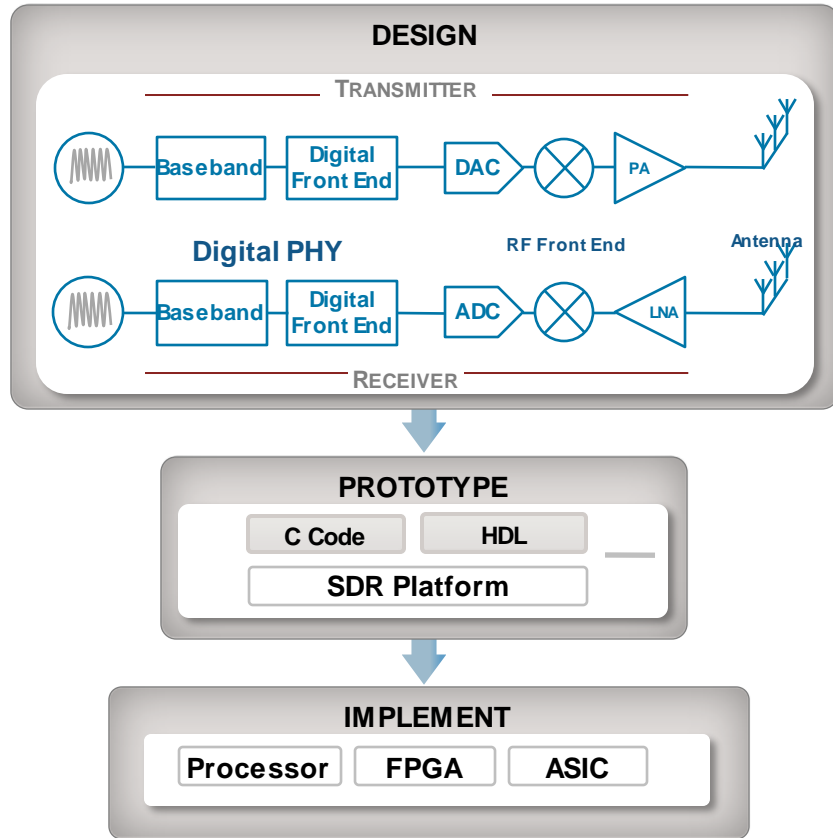
## Connect MATLAB and Simulink to Hardware

Search for supported hardware

– Explore hardware by vendor –

Popular: ARM®, Arduino®, Intel®, National Instruments™, Raspberry Pi™, AMD®, Android™, STMicroelectronics®, Keysight™

# Before TI Radar Support

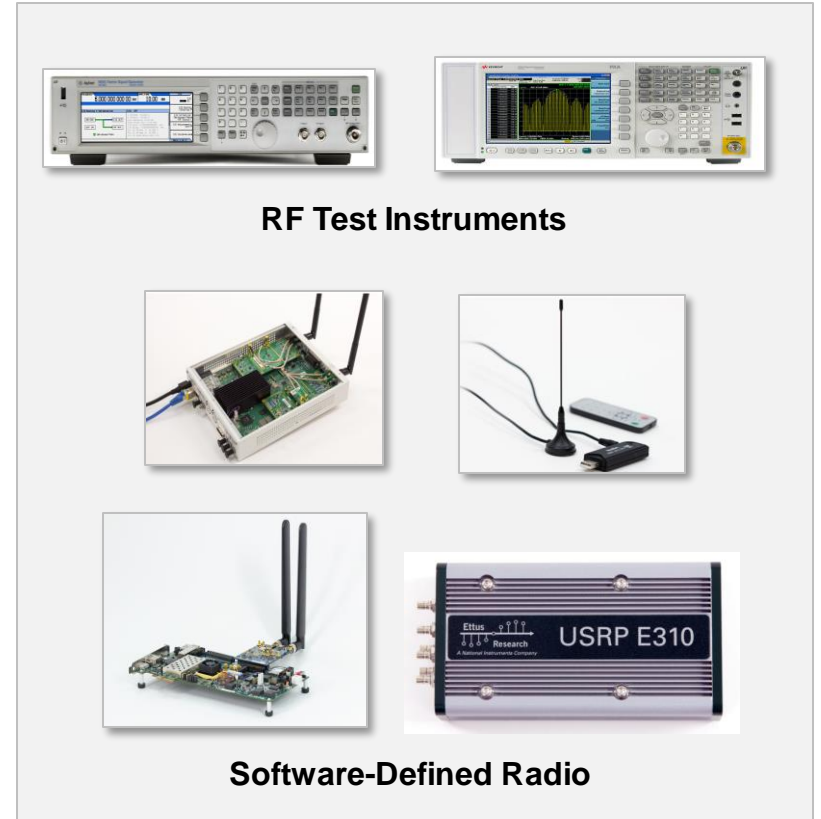


**HDL and C code generation**

Instrument Control Toolbox

SDR Support Packages  
*Communications System Toolbox*

Fixed-Point Designer  
SoC Blockset  
HDL Coder  
Embedded Coder  
Wireless HDL Toolbox




**Multi-vendor hardware support**

# Getting Started with TI mmWave Radar Sensors

## Required MathWorks® Products

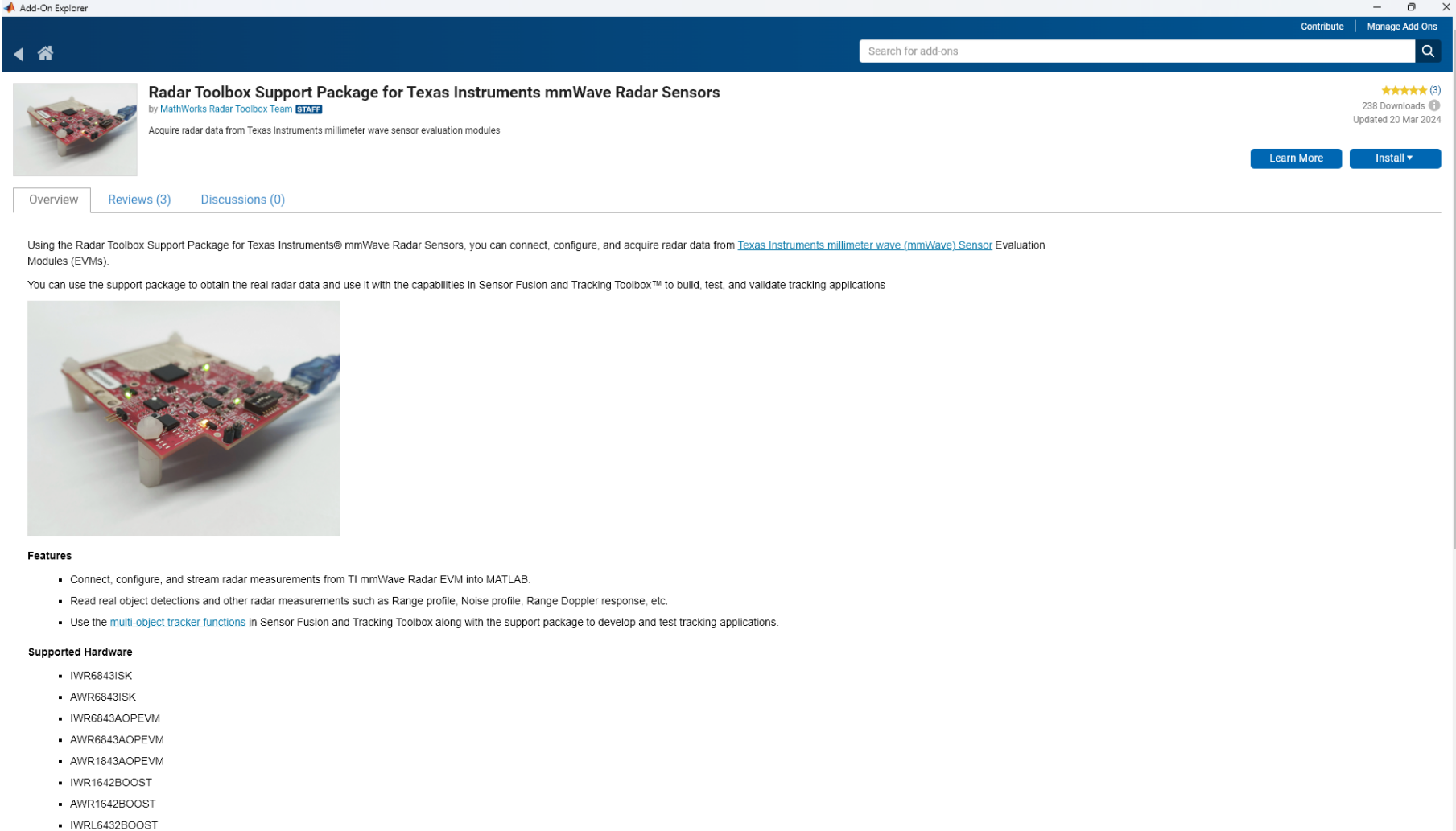
- MATLAB®
- Radar Toolbox
- Radar Toolbox Support Package for Texas Instruments mmWave Radar Sensors

The support package provides support for these EVMs:

- TI IWR6843ISK 
- TI AWR6843ISK
- TI IWR6843AOPEVM
- TI AWR6843AOPEVM
- TI AWR1843AOPEVM
- TI AWR1642BOOST
- TI IWR1642BOOST
- TI IWRL6432BOOST



# Support Package for Texas Instruments mmWave Radar Sensors



The screenshot displays the MATLAB Add-On Explorer interface. At the top, there is a search bar and navigation icons. The main content area features the title 'Radar Toolbox Support Package for Texas Instruments mmWave Radar Sensors' by the MathWorks Radar Toolbox Team. It includes a small image of a radar sensor module, a description 'Acquire radar data from Texas Instruments millimeter wave sensor evaluation modules', and statistics such as '238 Downloads' and 'Updated 20 Mar 2024'. There are 'Learn More' and 'Install' buttons. Below the title, there are tabs for 'Overview', 'Reviews (3)', and 'Discussions (0)'. The main text describes the package's purpose: 'Using the Radar Toolbox Support Package for Texas Instruments® mmWave Radar Sensors, you can connect, configure, and acquire radar data from Texas Instruments millimeter wave (mmWave) Sensor Evaluation Modules (EVMs). You can use the support package to obtain the real radar data and use it with the capabilities in Sensor Fusion and Tracking Toolbox™ to build, test, and validate tracking applications.' A larger image of the radar sensor module is shown. The 'Features' section lists: 'Connect, configure, and stream radar measurements from TI mmWave Radar EVM into MATLAB.', 'Read real object detections and other radar measurements such as Range profile, Noise profile, Range Doppler response, etc.', and 'Use the multi-object tracker functions in Sensor Fusion and Tracking Toolbox along with the support package to develop and test tracking applications.' The 'Supported Hardware' section lists: IWR6843ISK, AWR6843ISK, IWR6843AOPEVM, AWR6843AOPEVM, AWR1843AOPEVM, IWR1642BOOST, AWR1642BOOST, and IWR1642BOOST.

Add-On Explorer

Contribute | Manage Add-Ons

Search for add-ons

**Radar Toolbox Support Package for Texas Instruments mmWave Radar Sensors**  
by MathWorks Radar Toolbox Team **STAFF**

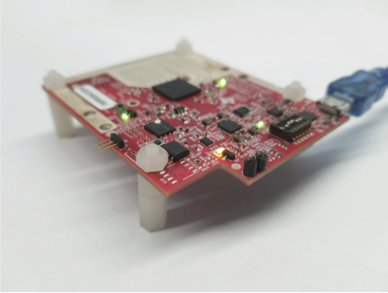
★★★★★ (3)  
238 Downloads  
Updated 20 Mar 2024

Learn More | Install

Overview | Reviews (3) | Discussions (0)

Using the Radar Toolbox Support Package for Texas Instruments® mmWave Radar Sensors, you can connect, configure, and acquire radar data from [Texas Instruments millimeter wave \(mmWave\) Sensor Evaluation Modules \(EVMs\)](#).

You can use the support package to obtain the real radar data and use it with the capabilities in Sensor Fusion and Tracking Toolbox™ to build, test, and validate tracking applications



**Features**

- Connect, configure, and stream radar measurements from TI mmWave Radar EVM into MATLAB.
- Read real object detections and other radar measurements such as Range profile, Noise profile, Range Doppler response, etc.
- Use the [multi-object tracker functions](#) in Sensor Fusion and Tracking Toolbox along with the support package to develop and test tracking applications.

**Supported Hardware**

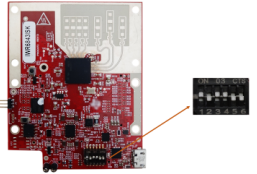
- IWR6843ISK
- AWR6843ISK
- IWR6843AOPEVM
- AWR6843AOPEVM
- AWR1843AOPEVM
- IWR1642BOOST
- AWR1642BOOST
- IWR1642BOOST



# Hardware Setup screens

Hardware Setup  
 Enable Flashing Mode > Flash Binary > Enable Functional Mode > Verify Radar Data Acquisition  
**Enable Flashing Mode (Step 1 of 3)**

Set the switches as shown in the image below



Switch	State
S1.1	On
S1.2	Off
S1.3	On
S1.4	On
S1.5	Off
S1.6	Off

**About Your Selection**  
 Prepare the radar board to download binary by setting the switches on board.

**What to Consider**  
 Switch positions are same for IWR6843ISK, AWR6843ISK, and IWR6843ISK-ODS boards

< Back Cancel Next >

Hardware Setup  
 Enable Flashing Mode > Flash Binary > Enable Functional Mode > Verify Radar Data Acquisition  
**Enable Flashing Mode (Step 2 of 3)**

Connect the micro-USB cable to the Radar device at the connector shown and then to a PC. LEDs on the device should turn on.

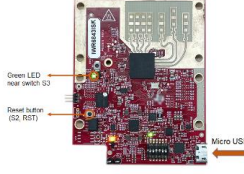


**What to Consider**  
 Communication and power supply to the radar device is via the USB connection.

< Back Cancel Next >

Hardware Setup  
 Enable Flashing Mode > Flash Binary > Enable Functional Mode > Verify Radar Data Acquisition  
**Enable Flashing Mode (Step 3 of 3)**

Reset the board by pressing and releasing the reset button 'S2' shown in the image. The green LED near S3 will toggle off and on when the switch is pressed and released.



**What to Consider**  
 Resetting ensures the switches are latched correctly.

< Back Cancel Next >

Hardware Setup  
 Enable Flashing Mode > Flash Binary > Enable Functional Mode > Verify Radar Data Acquisition  
**Flash Binary**

Choose config port: COM8 Choose data port: COM9 Refresh

Click 'Refresh' to update the config and data ports

To flash binary to the board, click 'Flash Binary'

Flash Binary

**About Your Selection**  
 Select the serial ports and flash mmWave demo binary (Out-of-box demo) to the Radar board

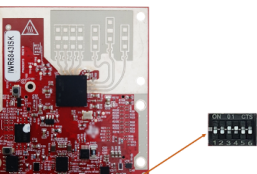
**What to Consider**  
 Config port name will be seen as either User UART or Enhanced COM port in Device manager. Data port name will be seen as either Data Port or Standard COM port in Device manager.

Ensure that you do not have any other connections to specified serial ports.

< Back Cancel Next >

Hardware Setup  
 Enable Flashing Mode > Flash Binary > Enable Functional Mode > Verify Radar Data Acquisition  
**Enable Functional Mode (Step 1 of 3)**

Set the switches as shown in the image below



Switch	State
S1.1	Off
S1.2	Off
S1.3	On
S1.4	On
S1.5	Off
S1.6	Off


**About Your Selection**  
 Prepare the radar board to configure and read data from the radar board by setting the switches on board.

**What to Consider**  
 Switch positions are same for IWR6843ISK, AWR6843ISK, and IWR6843ISK-ODS devices

< Back Cancel Next >

Hardware Setup  
 Enable Flashing Mode > Flash Binary > Enable Functional Mode > Verify Radar Data Acquisition  
**Enable Functional Mode (Step 2 of 3)**

Connect the micro-USB cable to the Radar device at the connector shown and then to a PC. LEDs on the device should turn on.




**What to Consider**  
 Communication and power supply to the radar device is via the USB connection.

< Back Cancel Next >

Hardware Setup  
 Enable Flashing Mode > Flash Binary > Enable Functional Mode > Verify Radar Data Acquisition  
**Enable Functional Mode (Step 3 of 3)**

Reset the board by pressing and releasing the reset button 'S2' shown in the image. The green LED near S3 will toggle off and on when the switch is pressed and released.



**What to Consider**  
 Resetting ensures the switches are latched correctly.

< Back Cancel Next >

Hardware Setup  
 Enable Flashing Mode > Flash Binary > Enable Functional Mode > Verify Radar Data Acquisition  
**Verify connection**

Choose config port: COM5 Choose data port: COM6 Test Connection

Click 'Test Connection' to check if MATLAB acquires data from TI mmWave Radar sensor.

Test Connection

**About Your Selection**  
 When you click 'Test Connection', MATLAB completes the configuration of the TI mmWave radar sensor and reads the data. If you observe that the format of the received data is as expected, the Hardware Setup is successful.

< Back Cancel Next >

# mmWaveRadar Object

```
>> rdr = mmWaveRadar("TI IWR6843ISK")

rdr =

mmWaveRadar with properties:

    BoardName: "TI IWR6843ISK"
    ConfigPort: "COM7"
    DataPort: "COM8"

    ConfigFile: "C:\Prototype\MaxRangResolution.cfg"

    SensorIndex: 1

    MountingLocation: [0,0,0]
    MountingAngle: [0,0,0]

    UpdateRate: 1
    RangeResolution: 4.400000e-02
    RangeRateResolution: 1.300000e-01
    AzimuthResolution: 14
    ElevationResolution: 25
    MaximumRange: 10
    MaximumRangeRate: 5
```

Show all [properties](#) all [functions](#)

```
>> [objDets, time, measurements, overrun] = rdr()

objDetections =
    3x1 cell array
    {1x1 objectDetection}
    {1x1 objectDetection}
    {1x1 objectDetection}

time =
     6

measurements =
    struct with fields:
        RangeProfile: [256x1 double]
        NoiseProfile: [256x1 double]
    RangeDopplerResponse: [256x16 double]
    RangeAngleResponse: [256x63 double]
        RangeGrid: [256x1 double]
        DopplerGrid: [16x1]
        AngleGrid: [64x1]

overrun =
     1
```



# TI mmWave Radar Board Configuration

## mmWave Demo visualizer application

- Platform
- Antenna Config
- Desirable Config
- Frequency Band

Save config to PC (.cfg)

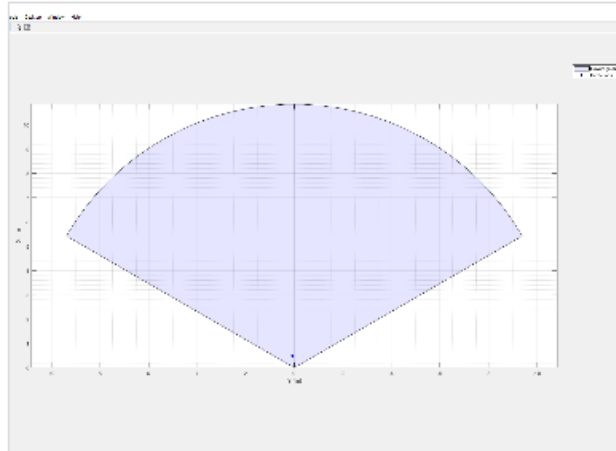
The screenshot shows the 'mmWave Demo Visualizer' application interface. The top navigation bar includes 'Options' and 'Help'. The main configuration area is titled 'Configure' and is divided into several sections:

- Setup Details:** Platform (xWR16xx), SDK version (\*), and Antenna Config (Azimuth Res - deg) (4Rx,2Tx(15 deg)).
- Desirable Configuration:** Best Range, Frequency Band (GHz) (77-81), and Calibration Data Save/Restore (None, 0x1F0000).
- Scene Selection:** Frame Rate (fps) (1 to 30, set to 10), Range Resolution (m) (0.977 to 0.061, set to 0.15), Maximum Unambiguous Range (m) (5 to 50, set to 50), Maximum Radial Velocity (m/s) (0.32 to 5.89, set to 3.1), and Radial Velocity Resolution (m/s) (0.39).
- Plot Selection:** Scatter Plot (checked), Range Profile (checked), Noise Profile (unchecked), Range Azimuth Heat Map (unchecked), Range Doppler Heat Map (unchecked), and Statistics (checked).
- RCS:** Desired Radar Cross Section (sq. m) (0.5), Maximum Range for desired RCS (m) (38.298), and RCS at Max Unambiguous Range (sq. m) (1.452631).
- Console Messages:** A large empty area for displaying messages, with a 'CLEAR CONSOLE' button at the bottom right.

At the bottom of the configuration area, there are three buttons: 'SEND CONFIG TO MMWAVE DEVICE', 'SAVE CONFIG TO PC', and 'RESET SELECTION'.

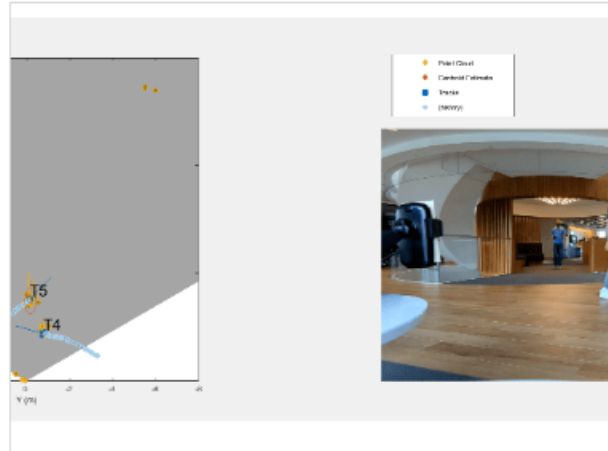
(\*) For SDK 2.1 LTS release, please use this link: [https://dev.ti.com/gallery/view/mmwave/mmWave\\_Demo\\_Visualizer/ver/2.1.0/](https://dev.ti.com/gallery/view/mmwave/mmWave_Demo_Visualizer/ver/2.1.0/)

# TI mmWave Radar Examples



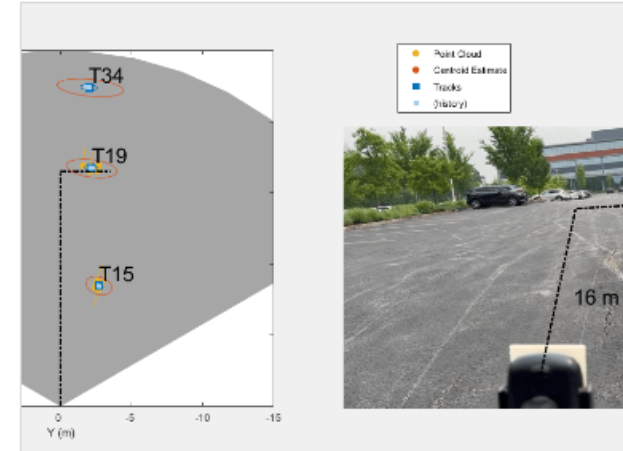
## Getting Started with Radar Toolbox Support Package for Texas Instruments mmWave...

Use Radar Toolbox Support Package for Texas Instruments® mmWave Radar Sensors to configure and read detections (point cloud data) and



## People Tracking Using TI mmWave Radar

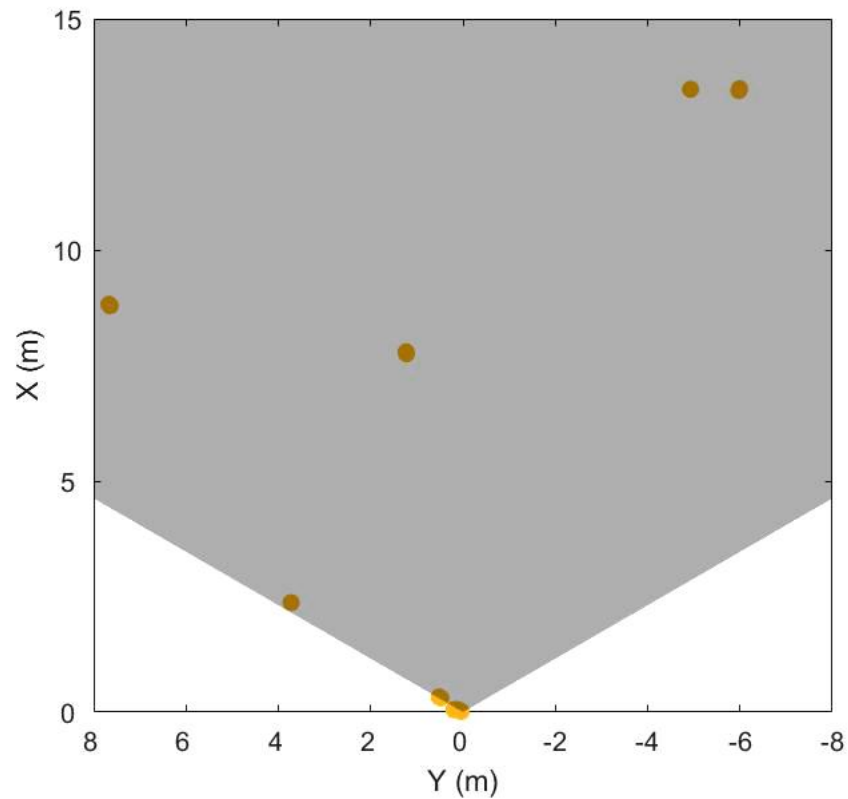
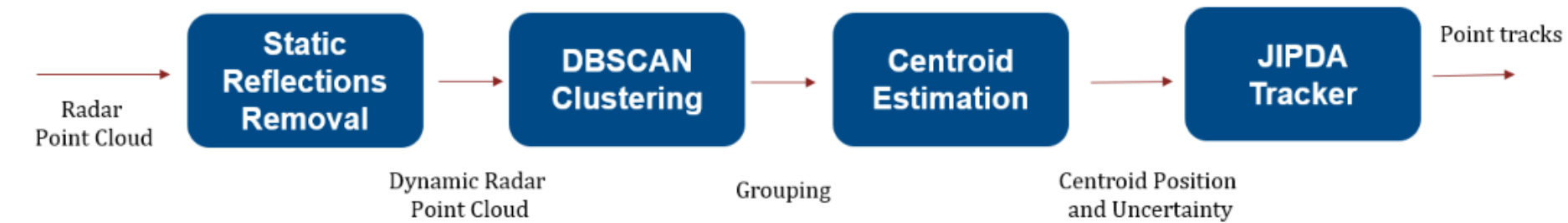
Use data captured using the Texas Instruments (TI) mmWave radar for tracking people in an indoor environment. You learn how to use a



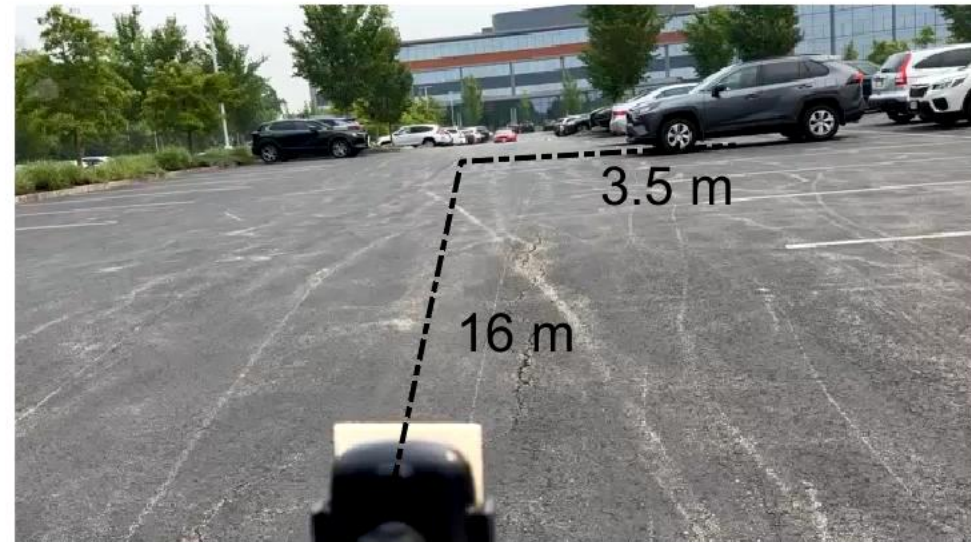
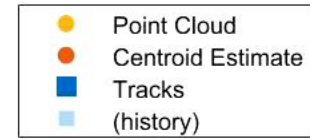
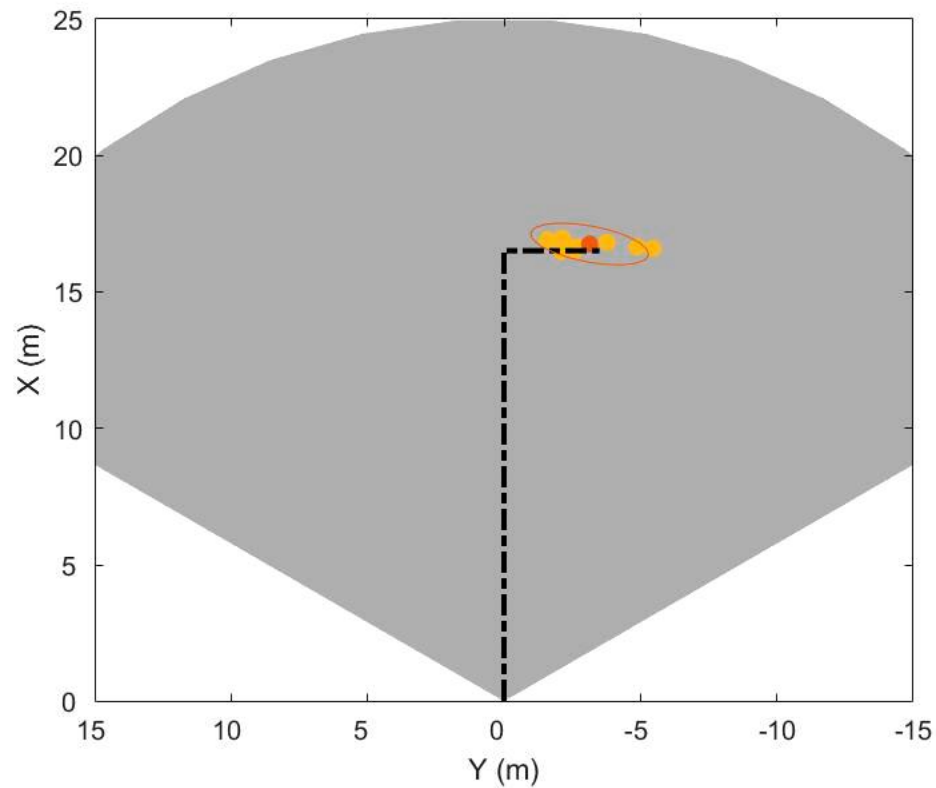
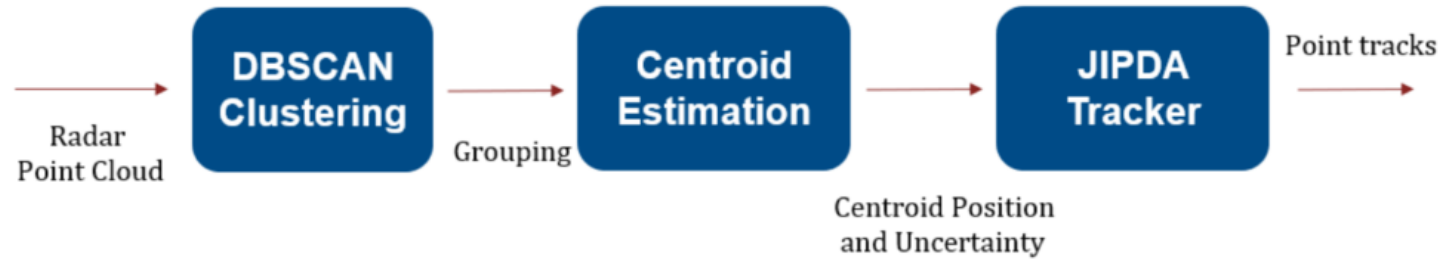
## Track Objects in a Parking Lot Using TI mmWave Radar

Use data captured using the Texas Instruments (TI) mmWave radar for tracking objects in a parking lot. You learn how to use a processing chain

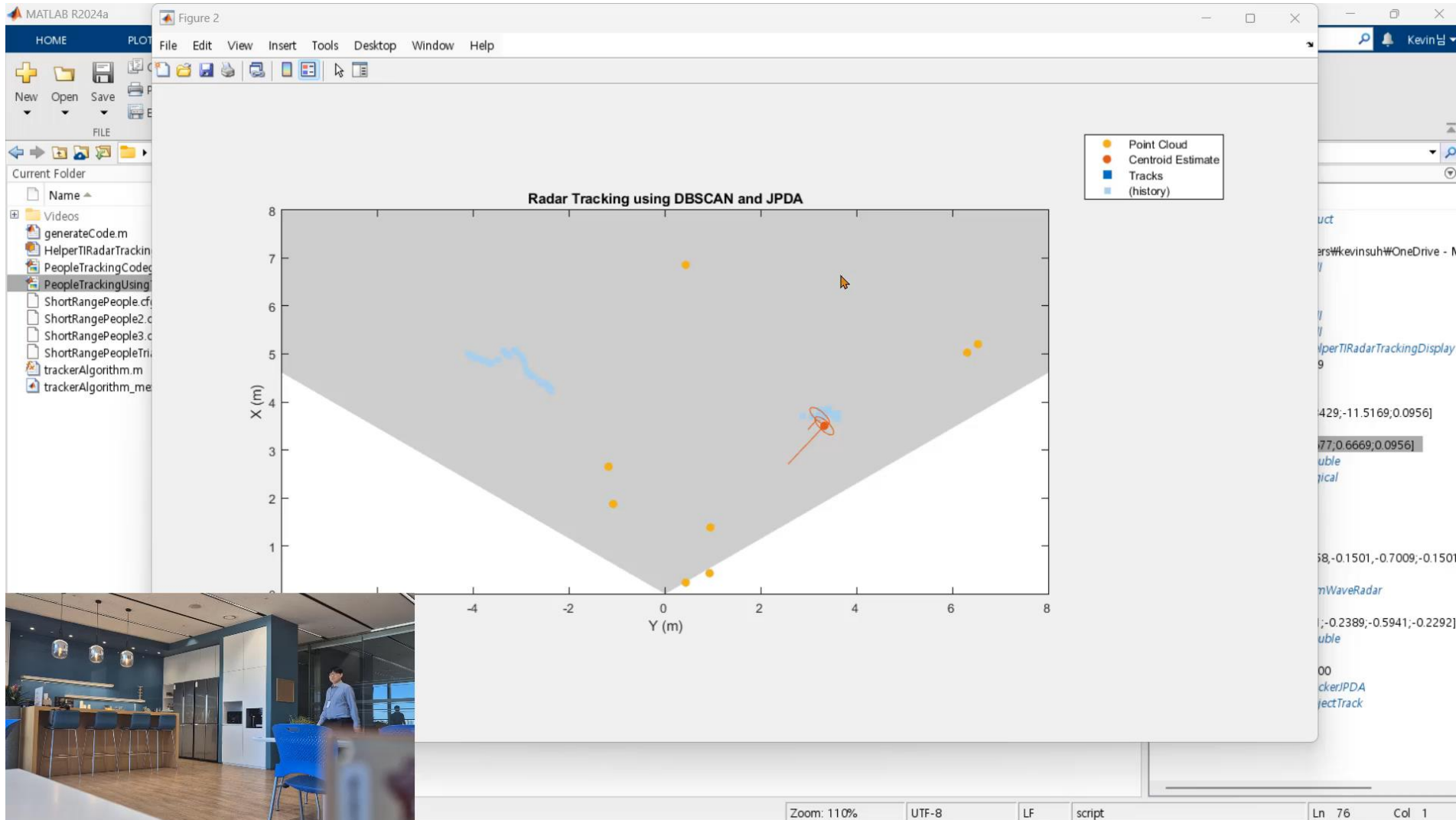
# People Tracking Using TI mmWave Radar



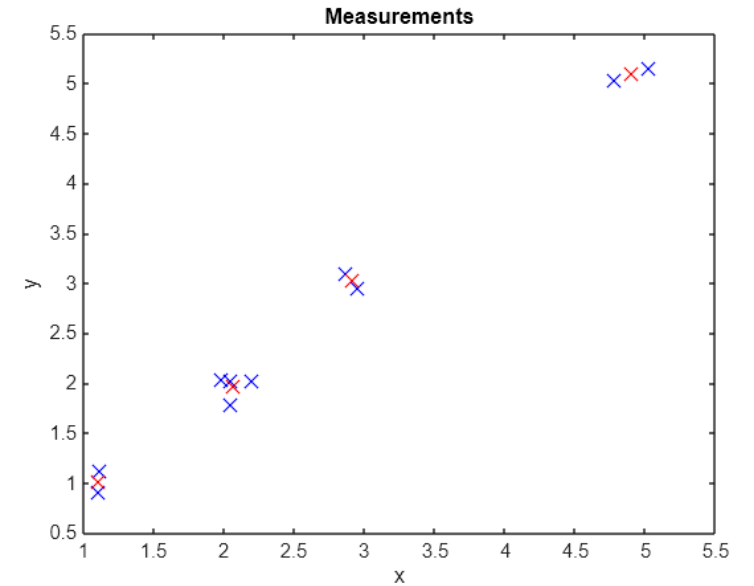
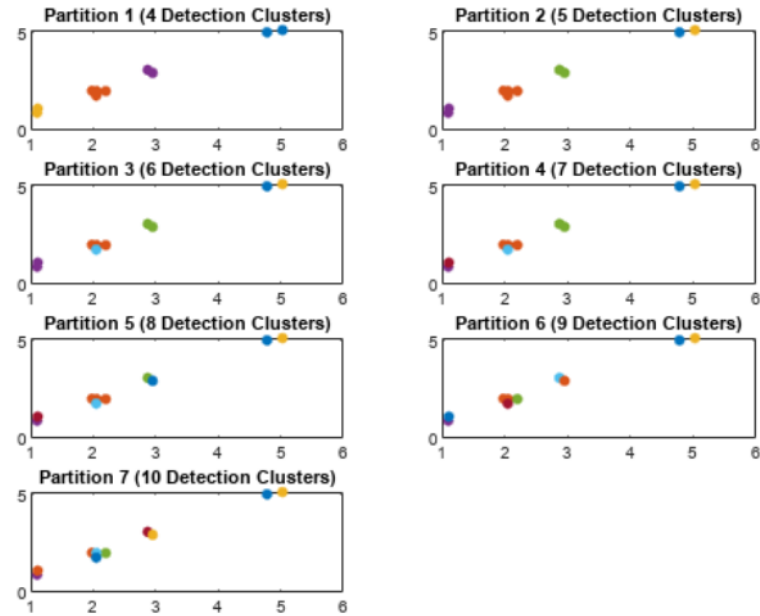
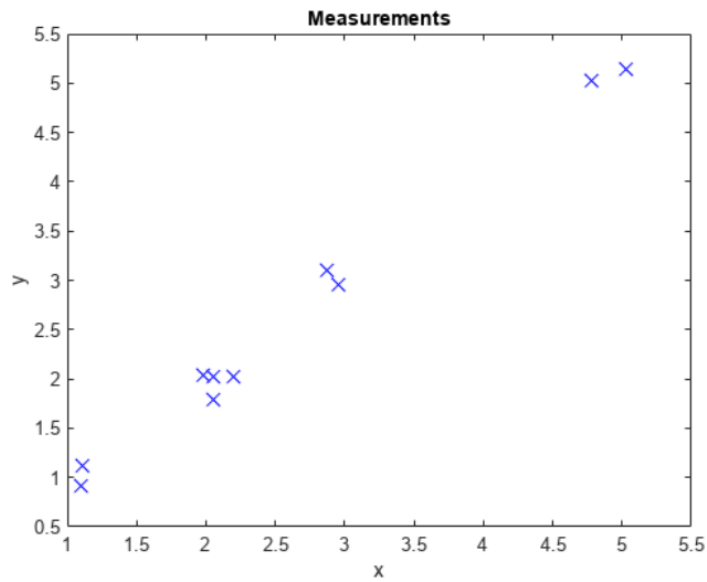
# Track Objects in a Parking Lot Using TI mmWave Radar



# Live Demo at the Demo Booth



# DBSCAN Clustering – Centroid Estimation



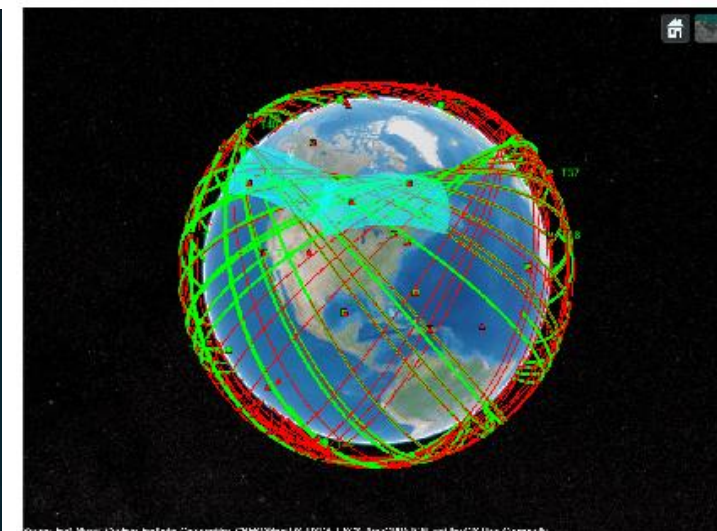
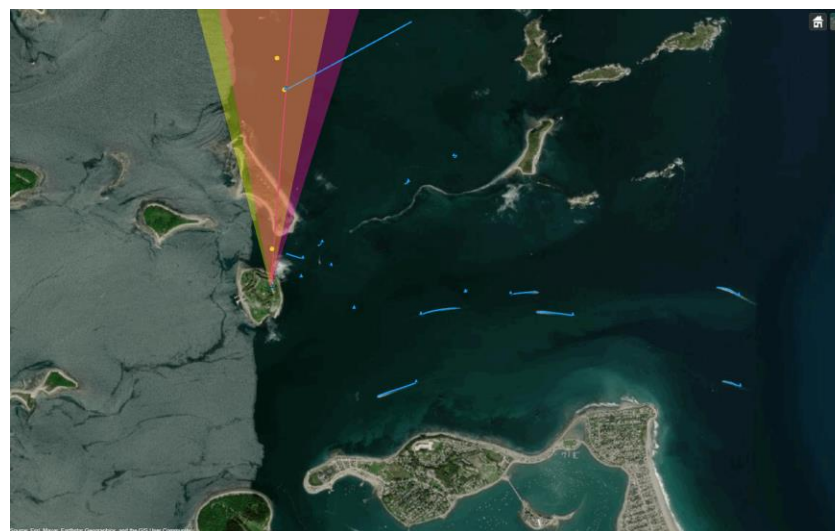
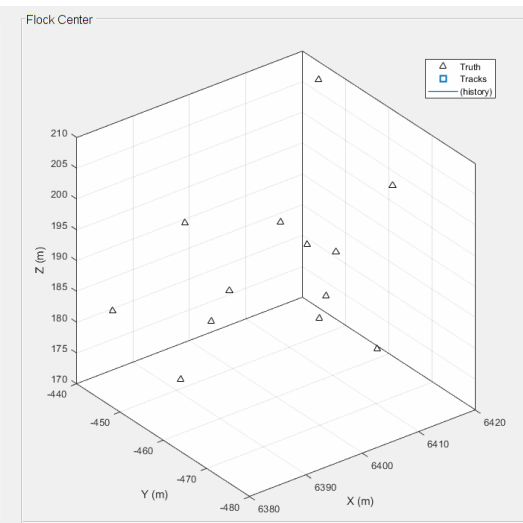
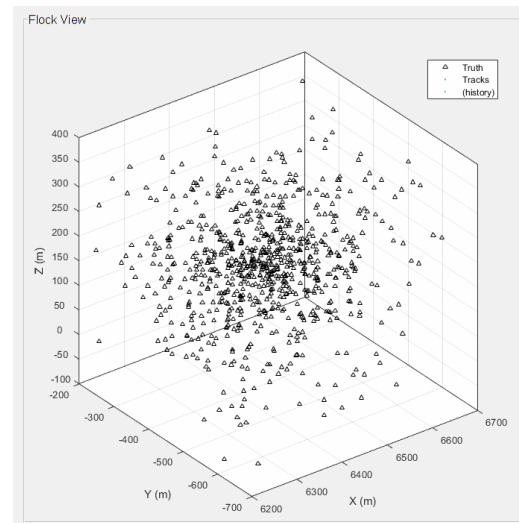
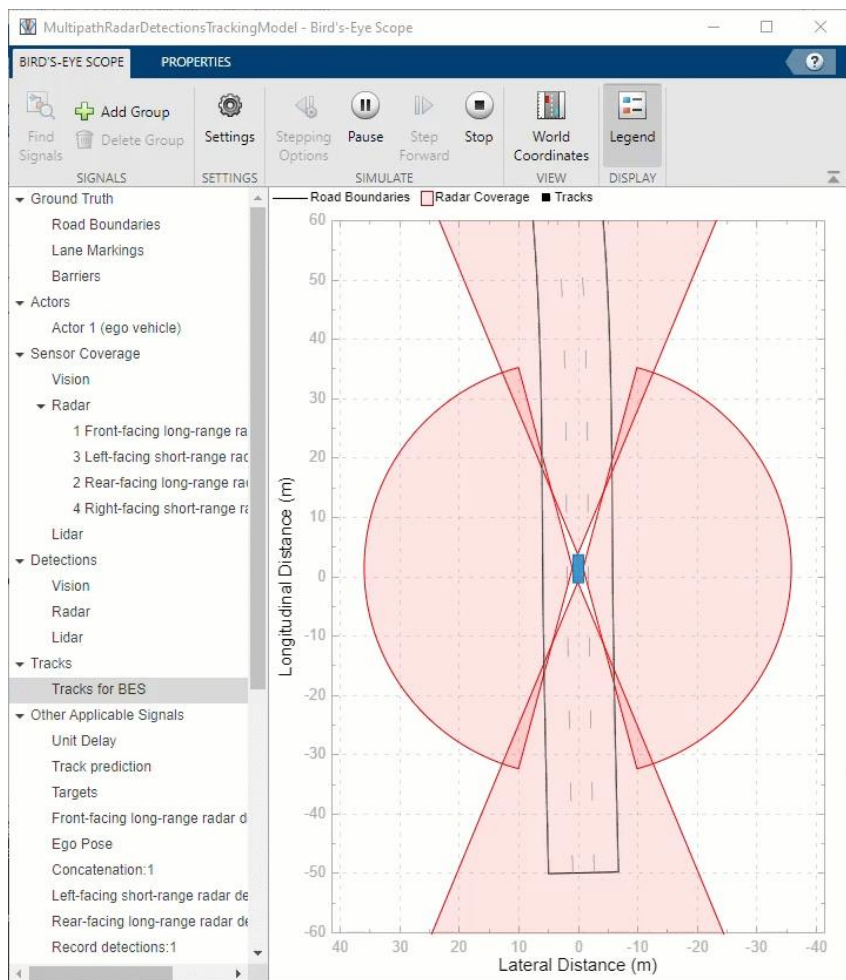
partitionDetections



mergeDetections



# Trackers for Various Applications



# MATLAB EXPO



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