MATLAB EXPO

2024.06.11 | 그랜드 인터컨티넨탈 서울 파르나스

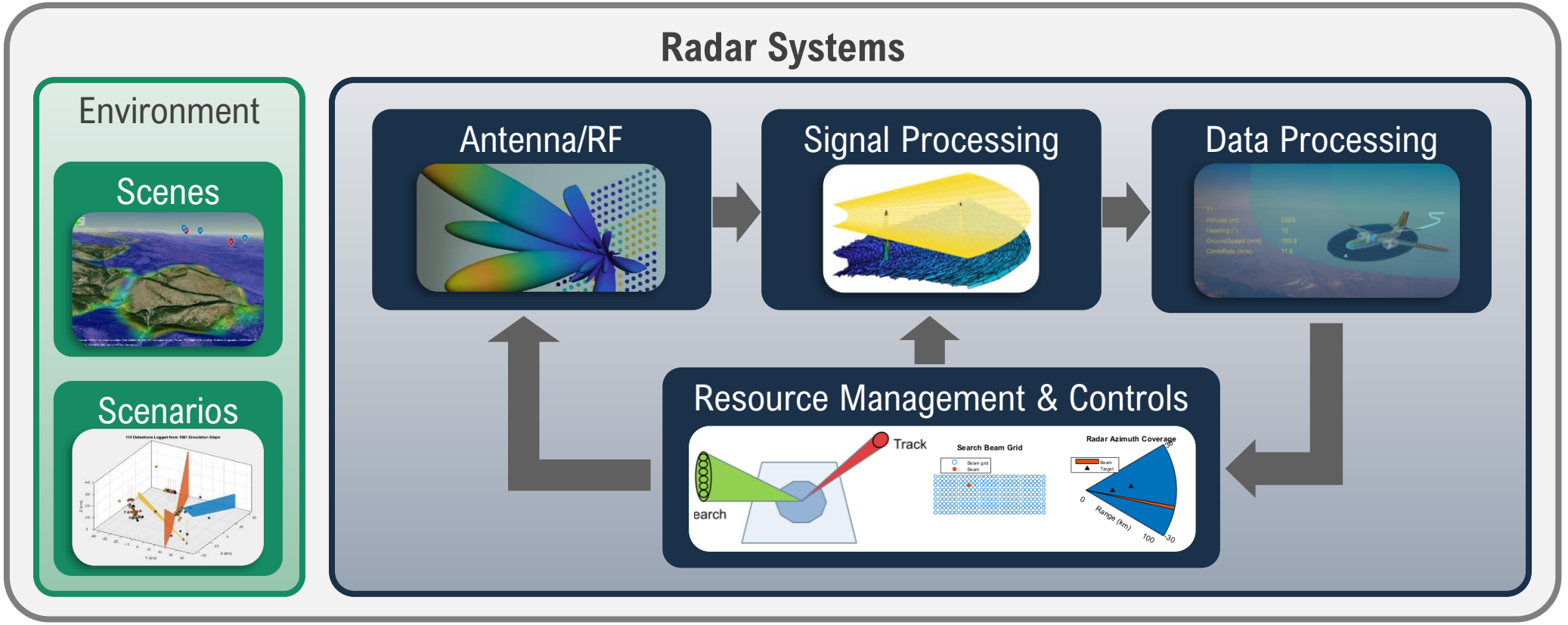
MATLAB을 활용한 TI mmWave 레이더 개발

서기환, MathWorks

MathWorks

Develop Radar Systems

with MATLAB and Simulink



Tracking Algorithm Development Workflow

Recorded Sensor Data

Scenario Definition and Sensor Simulation

Ownship Trajectory Generation → INS Sensor Simulation

Actors/ Platforms → Radar, IR, & Sonar Sensor Simulation

objectDetection

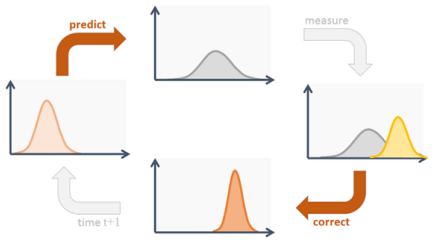
Tracking Algorithms

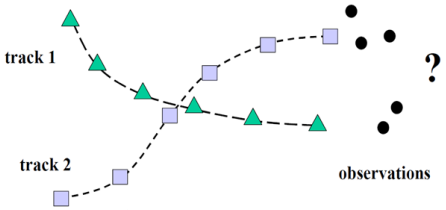
GNN, MHT, etc..

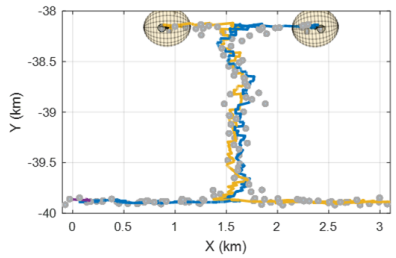
tracks

Visualization & Metrics

A rich library of tracking algorithms







Filters

- Alpha Beta filter
- Kalman filters
  - Linear, EKF, UKF, CKF, MSCEKF
- Particle filter
- Multiple models
  - GSF, IMM

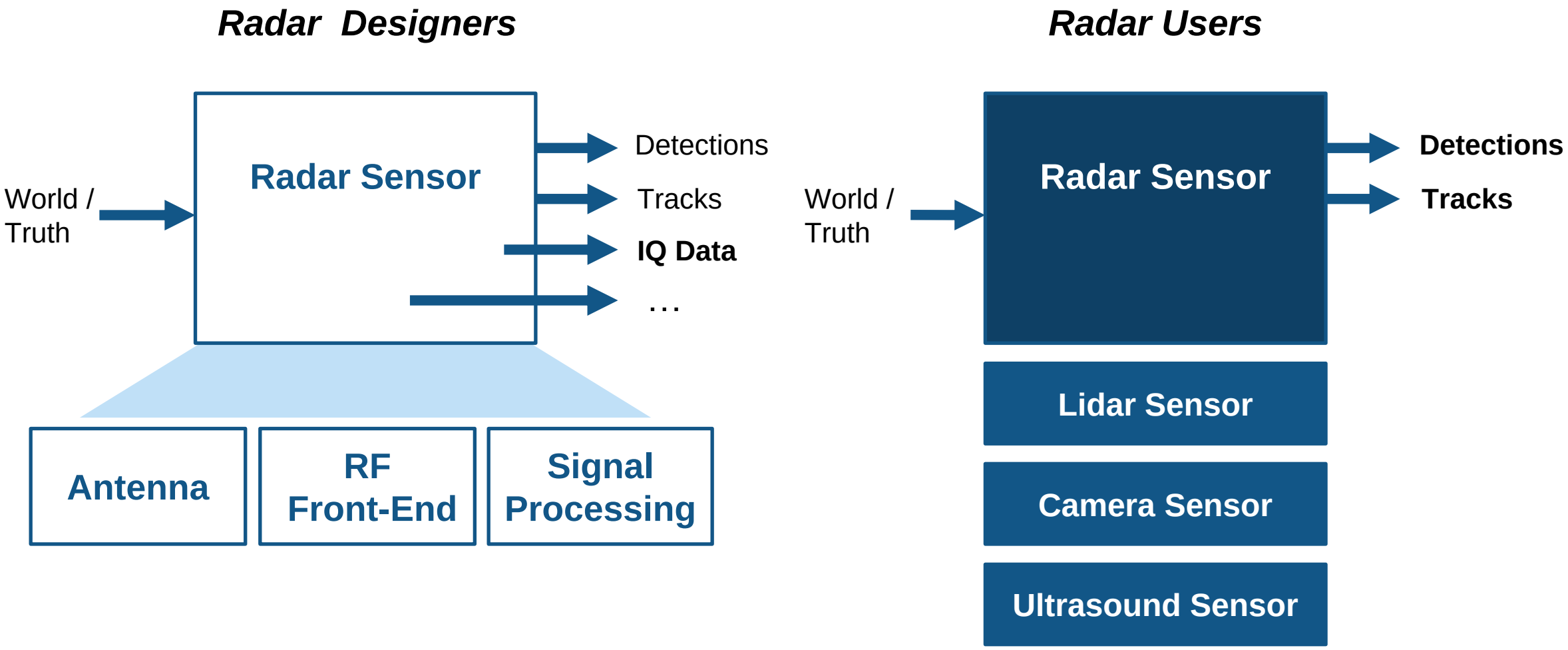
Data Association

- 2D assignment
- S-D assignment
- K-best assignmemt

Trackers

- GNN, JPDA, PHD
- MHT (track-oriented)
- Trackers components
  - History and score logic
  - etc……

Two Personas using Radar Sensor Models

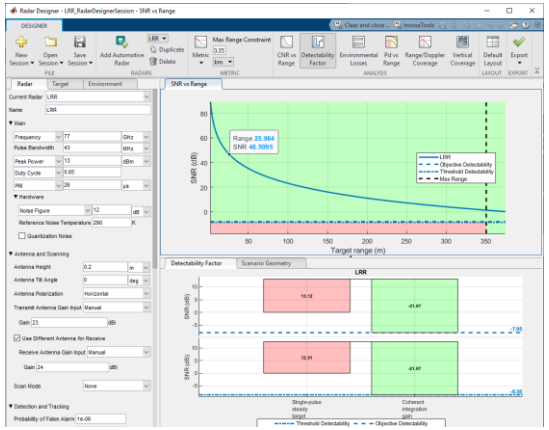


Three Abstraction Levels for Support of Full Radar Life Cycle

Less ← ***Fidelity*** → *More*

Power-level

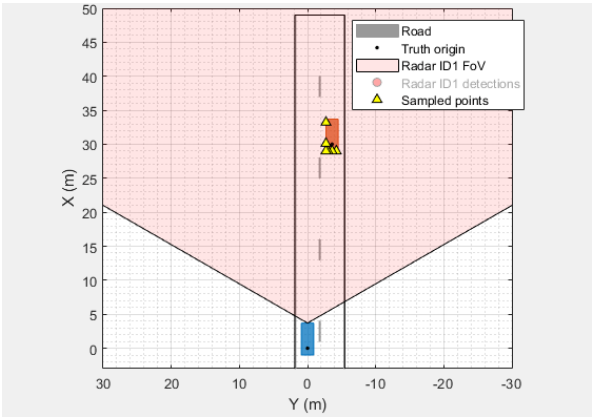
Link Budget



Applications: Concept Dev/Design, Systems Analysis

Measurement-level

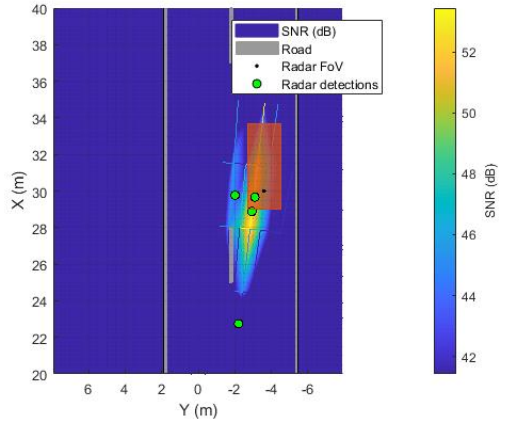
Detections



Applications: Systems Analysis, Scenario Analysis, Tracker Design

Waveform-level

Raw IQ

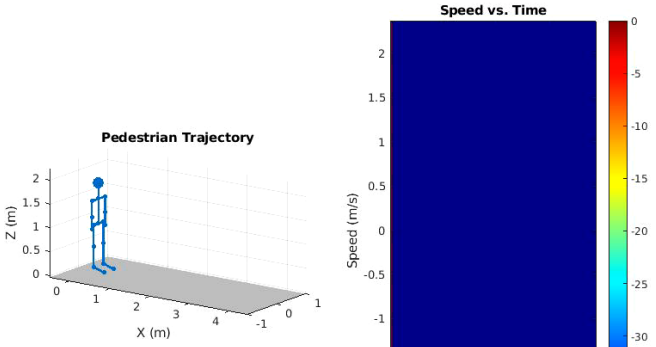


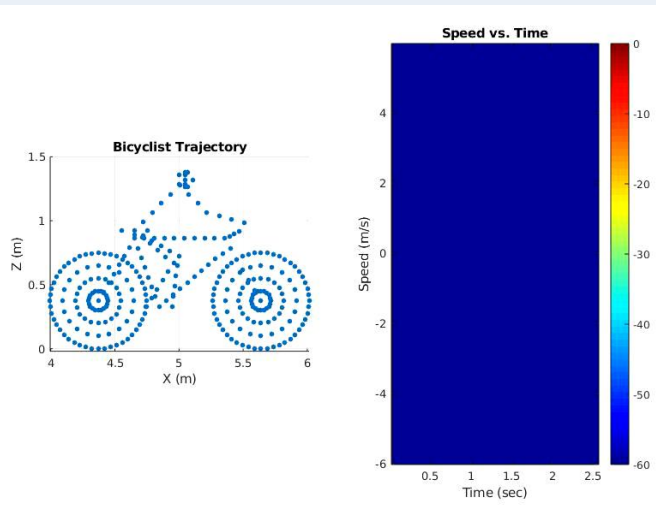
Applications: Algorithm Development, End-to-End Performance Assessment

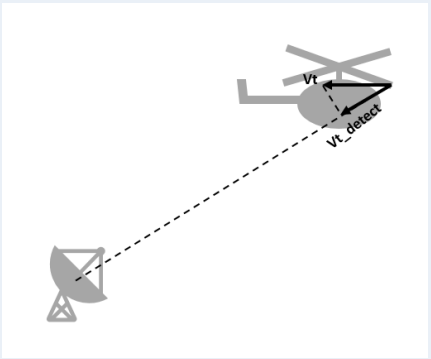
** See Design and Simulate an FMCW Long-Range Radar (LRR) Example here*

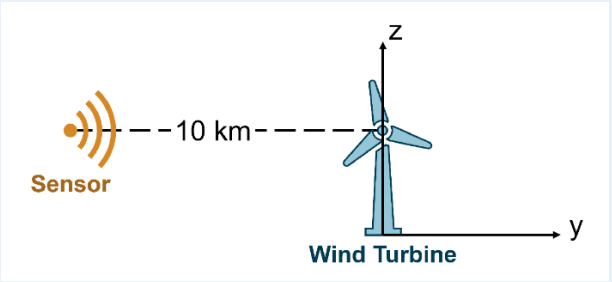
Radar Data Synthesis

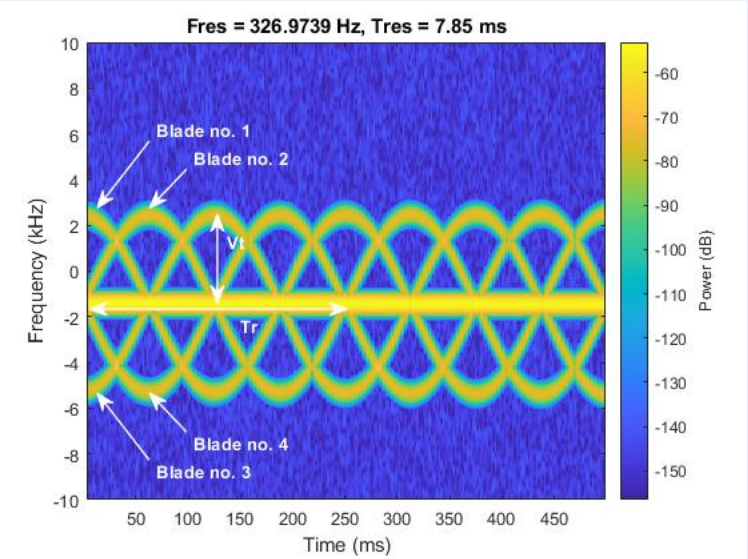
Micro-Doppler signatures

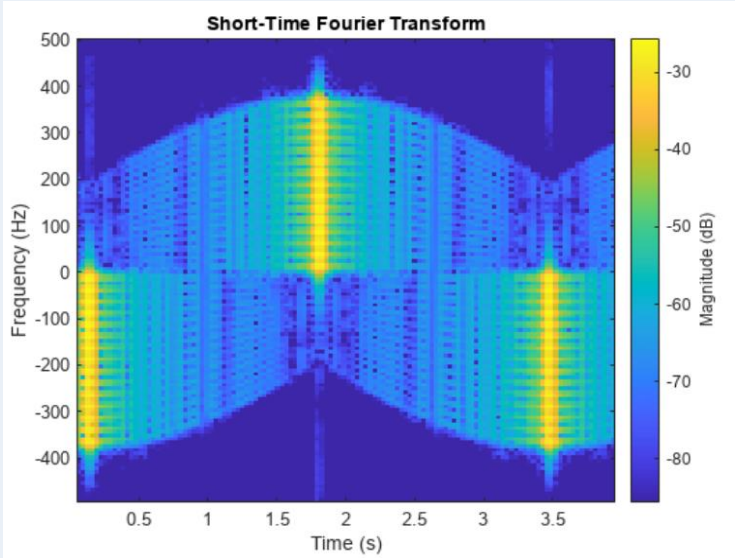




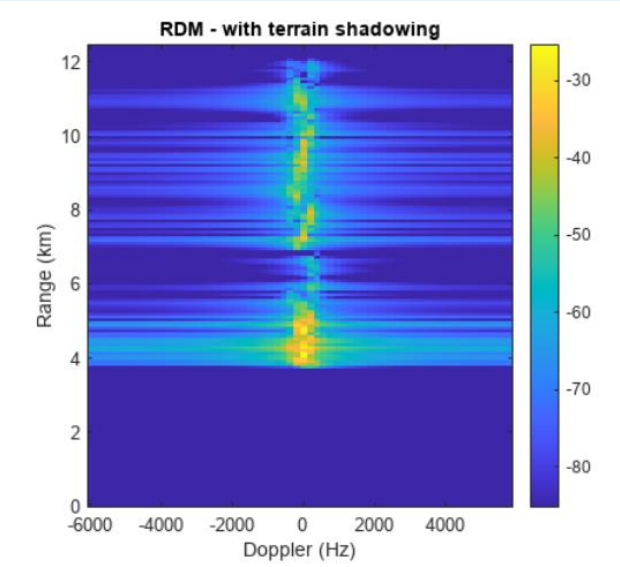


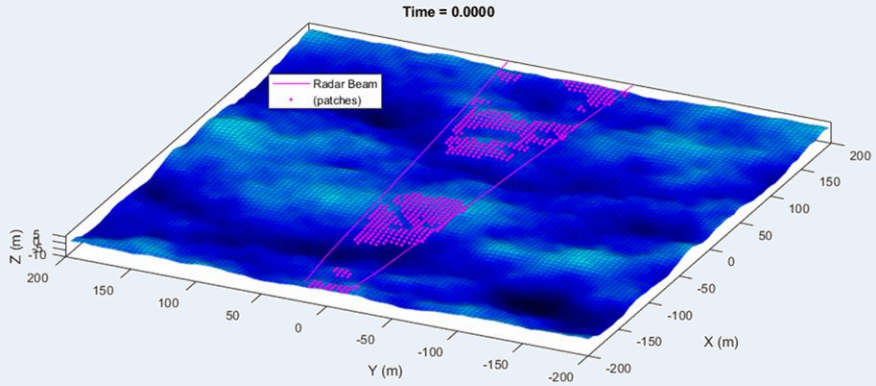


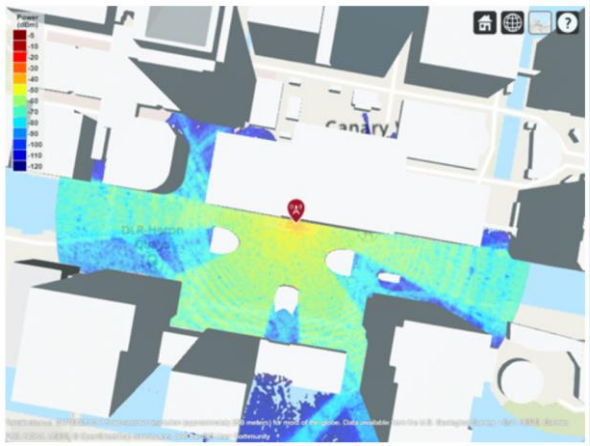


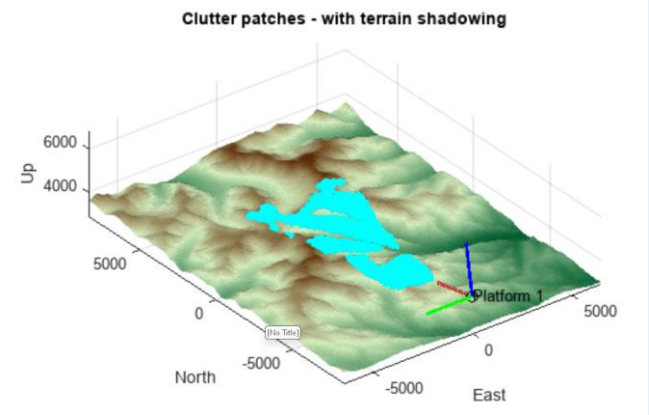


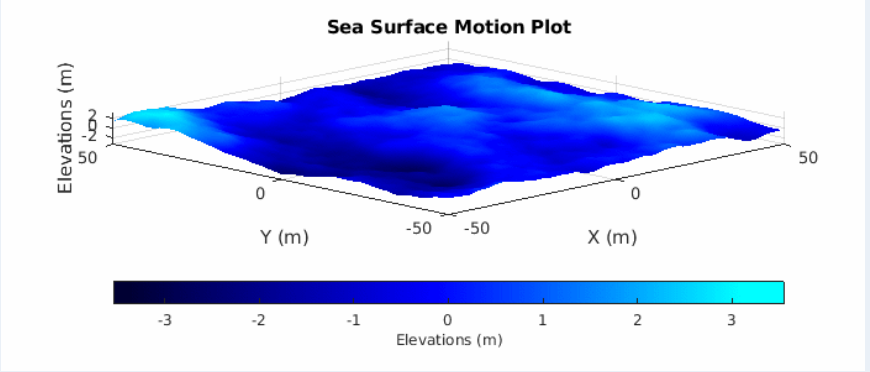
Clutter and Channel Modeling

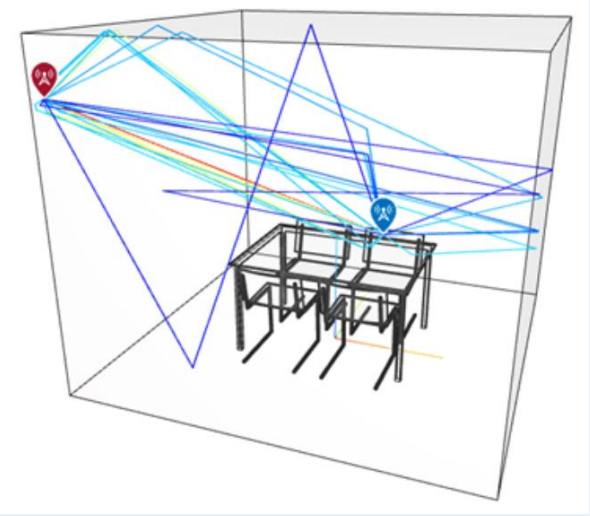




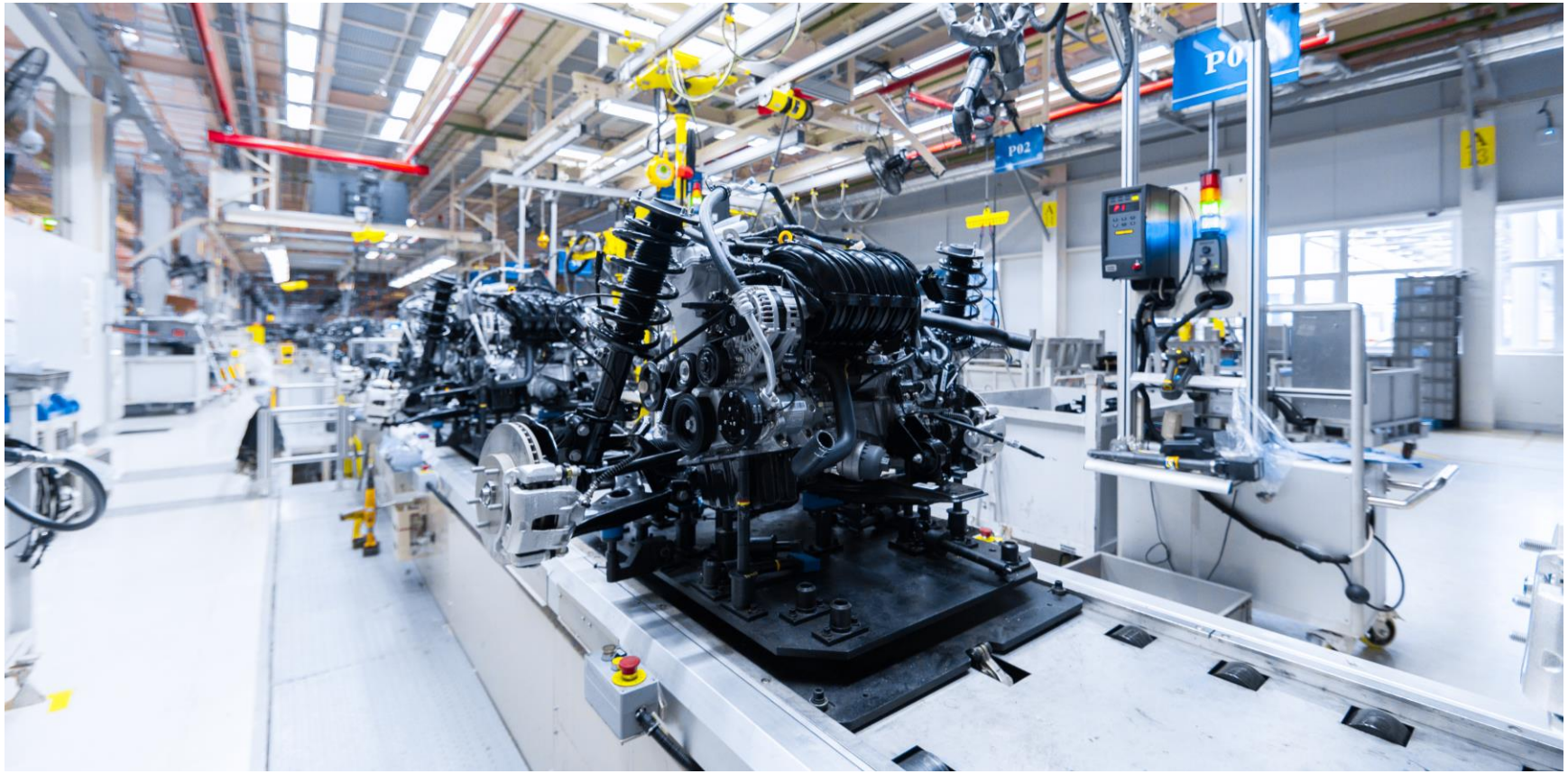






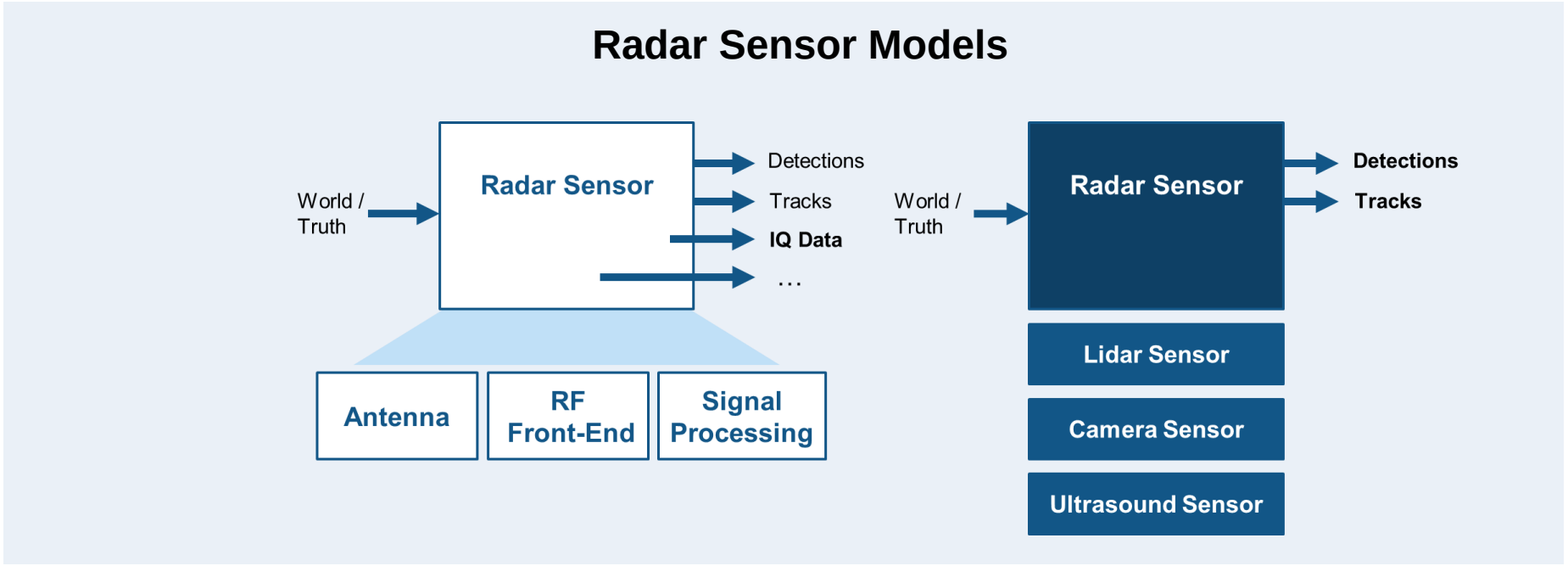


The Reality is…

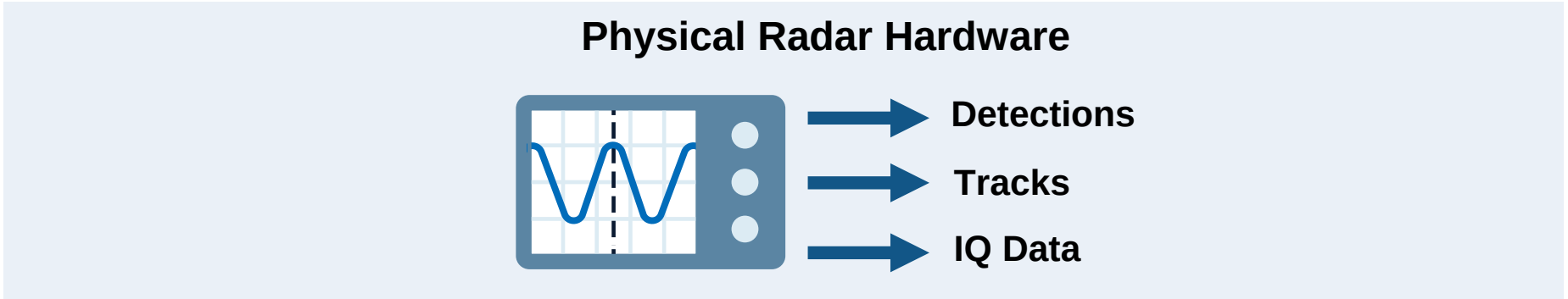


How can we model this environment?

Test and Verification of the Radar

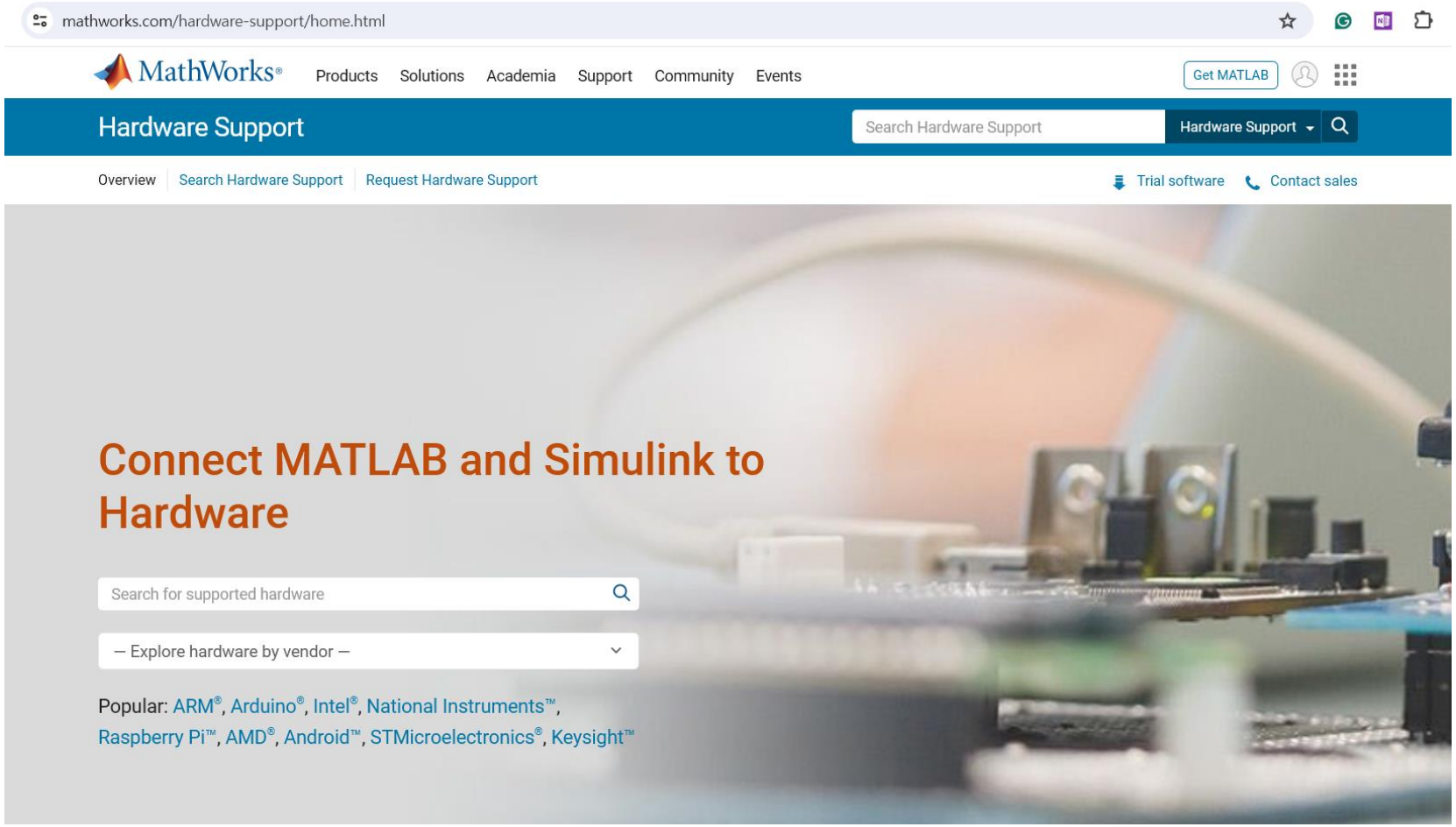


TEST AND VERIFICATION

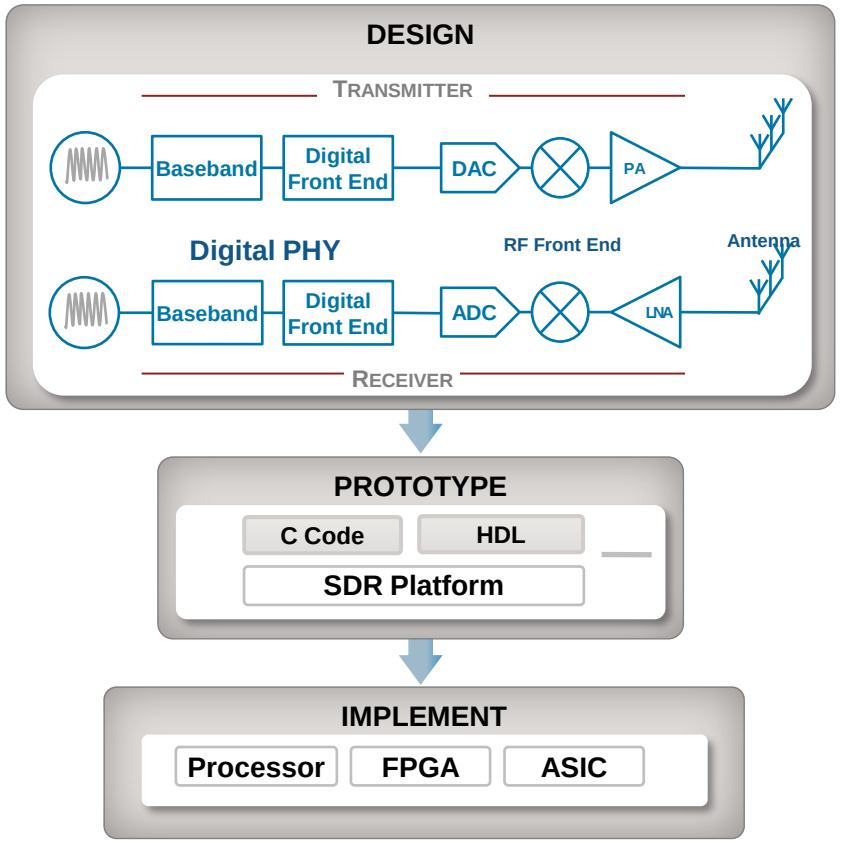


Connect MATLAB to Hardware

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



Before TI Radar Support

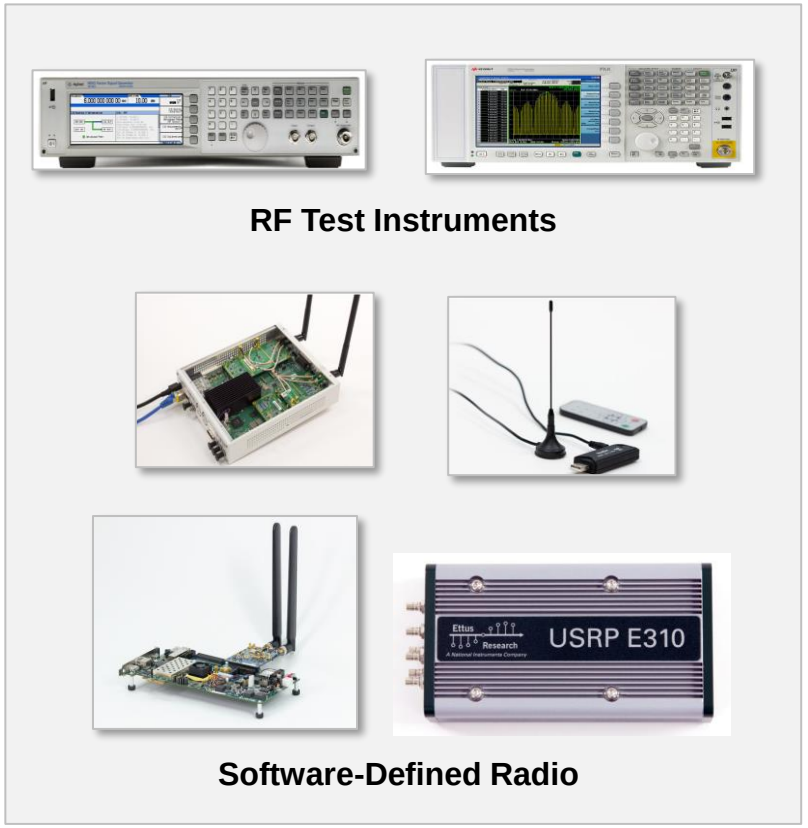


HDL and C code generation

Instrument Control Toolbox

SDR Support Packages
Communications System Toolbox

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



RF Test Instruments

Software-Defined Radio

Multi-vendor hardware support

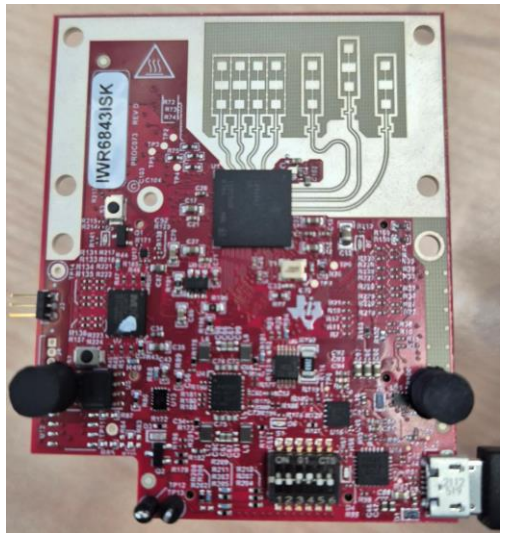
Getting Started with TI mmWave Radar Sensors

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

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

Acquire radar data from Texas Instruments millimeter wave sensor evaluation modules

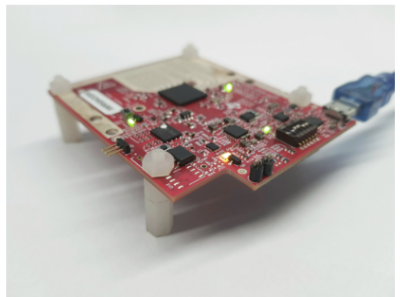
★★★★★ (3)
238 Downloads
Updated 20 Mar 2024

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



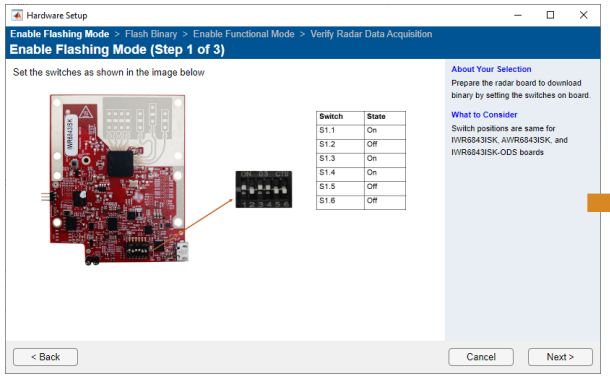
Features

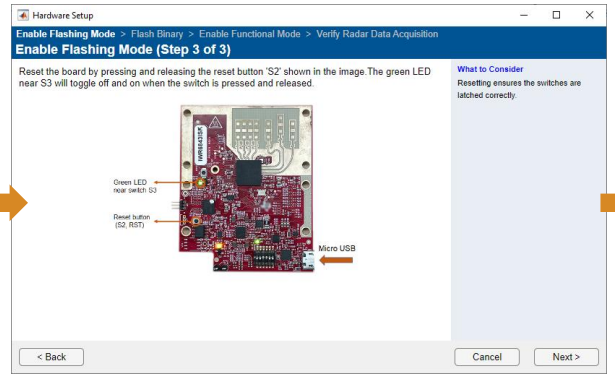
- Connect, configure, and stream radar measurements from TI mmWave Radar EVM into MATLAB.
- Read real object detections and other radar measurements such as Range profile, Noise profile, Range Doppler response, etc.
- Use the multi-object tracker functions in Sensor Fusion and Tracking Toolbox along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

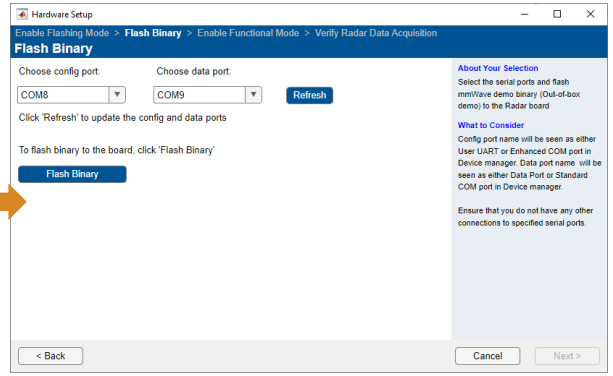
Supported Hardware

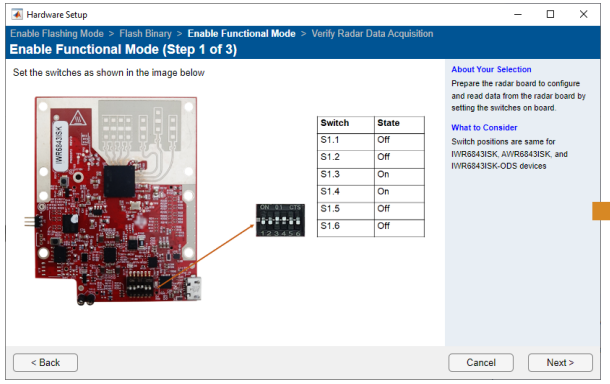
- IWR6843ISK
- AWR6843ISK
- IWR6843AOPEVM
- AWR6843AOPEVM
- AWR1843AOPEVM
- IWR1642BOOST
- AWR1642BOOST
- IWRL6432BOOST

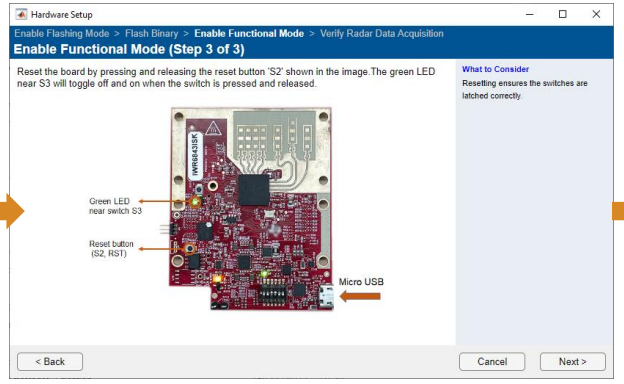
Hardware Setup screens

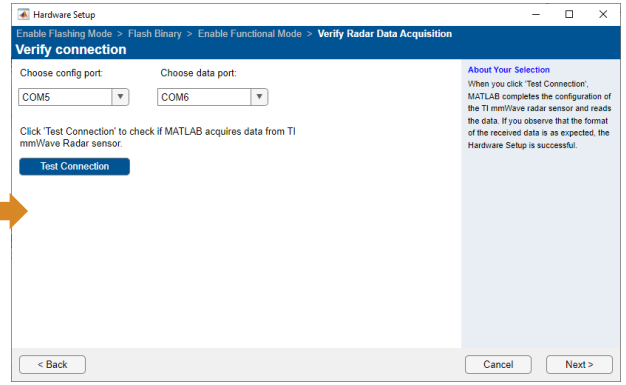












mmWaveRadar Object

```
>> 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
```

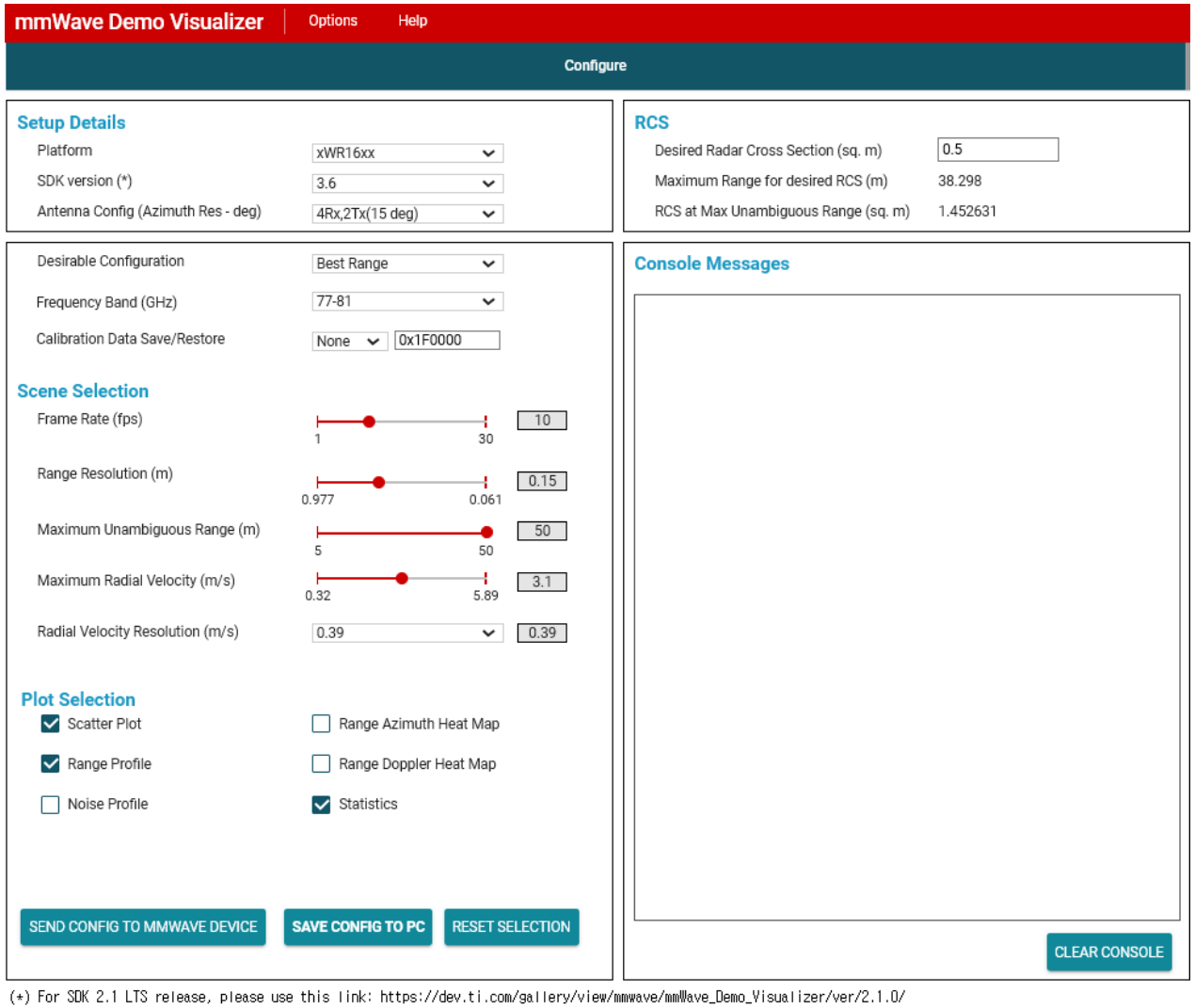
```
>> [objDets, time, measurements, overrun] = rdr()

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

                    time  =
                               6

            measurements  =
              struct with fields:
                    RangeProfile: [256×1 double]
                    NoiseProfile: [256×1 double]
                RangeDopplerResponse: [256×16 double]
                RangeAngleResponse: [256×63 double]
                         RangeGrid: [256×1 double]
                       DopplerGrid: [16x1]
                         AngleGrid: [64x1]

                 overrun  =

                               1
```

TI mmWave Radar Board Configuration

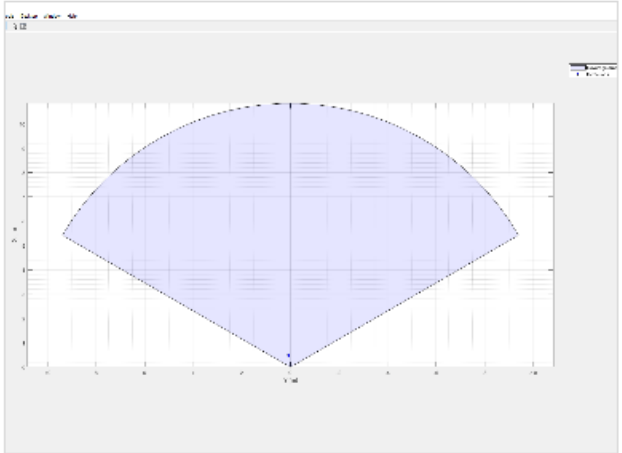
mmWave Demo visualizer application

- Platform
- Antenna Config
- Desirable Config
- Frequency Band

Save config to PC (.cfg)

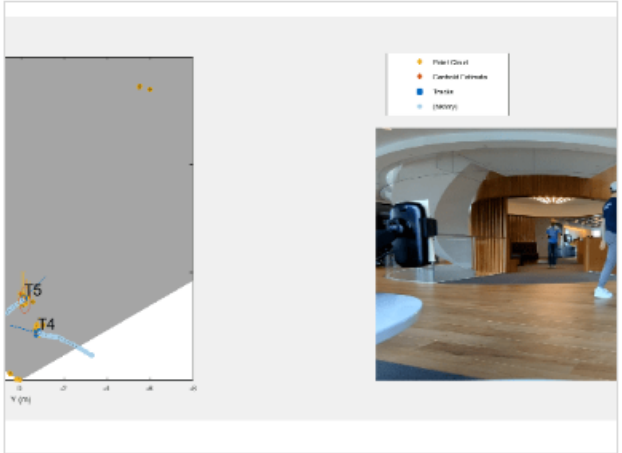


TI mmWave Radar Examples



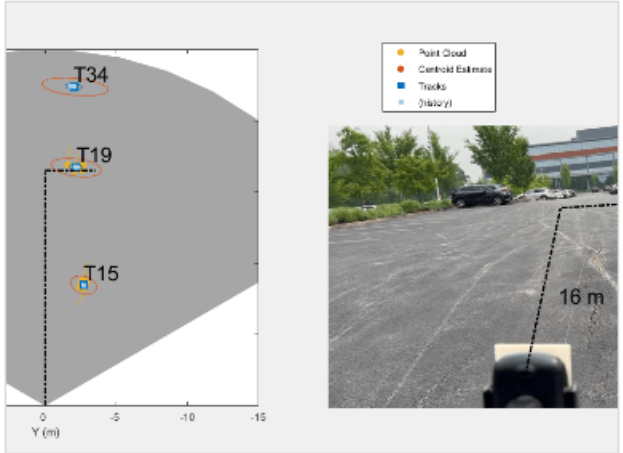
Getting Started with Radar Toolbox Support Package for Texas Instruments mmWav...

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

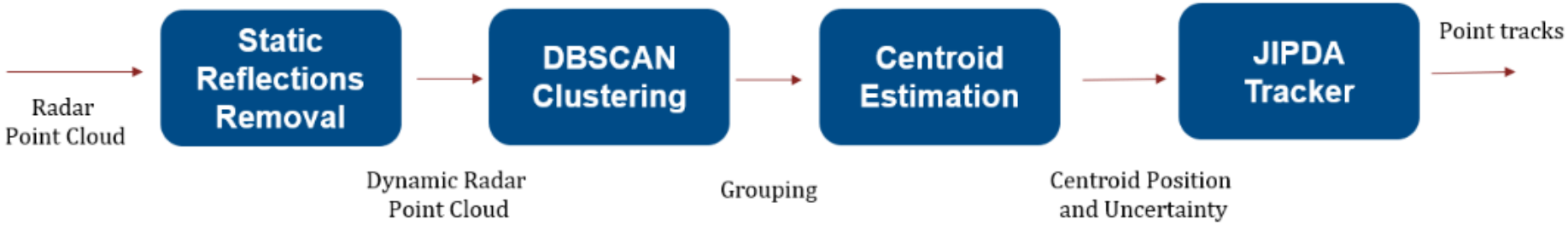
Use data captured using the Texas Instruments (TI) mmWave radar for tracking people in an indoor environment. You learn how to use a

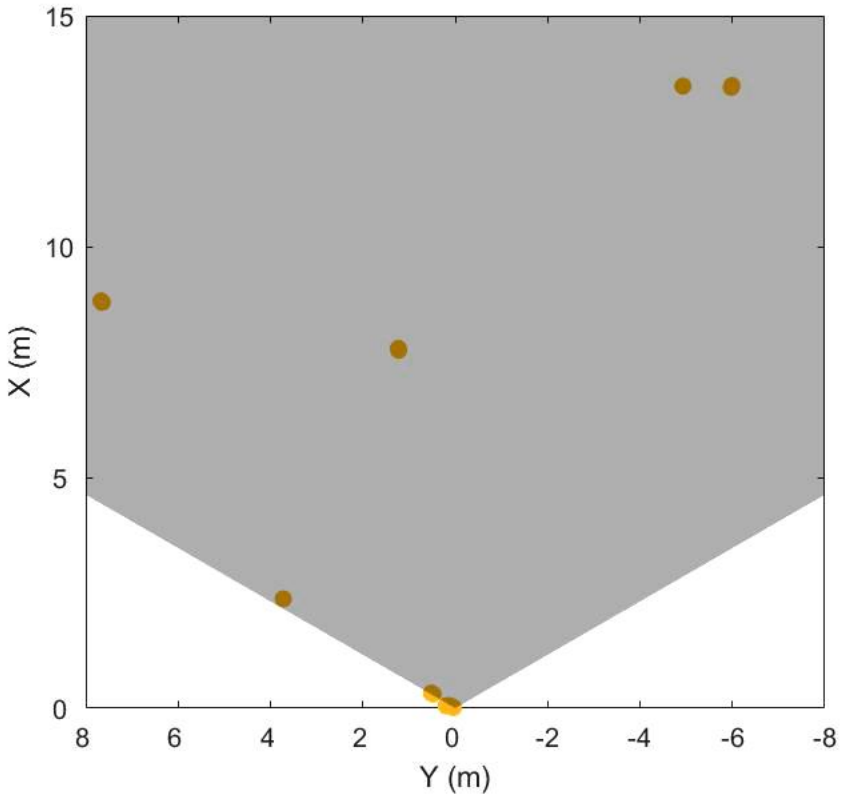


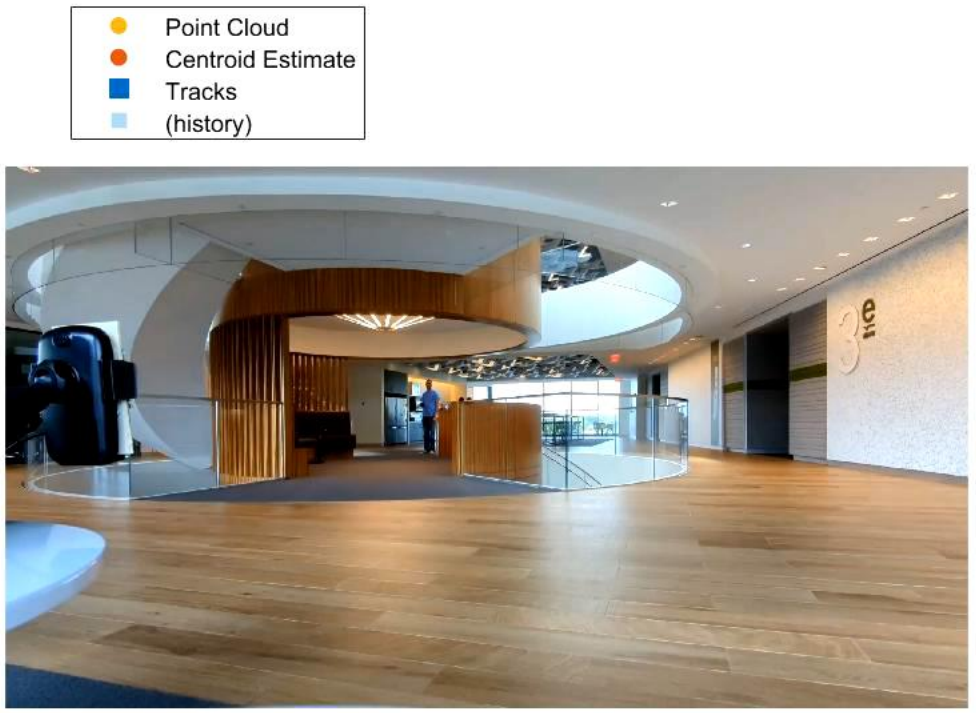
Track Objects in a Parking Lot Using TI mmWave Radar

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

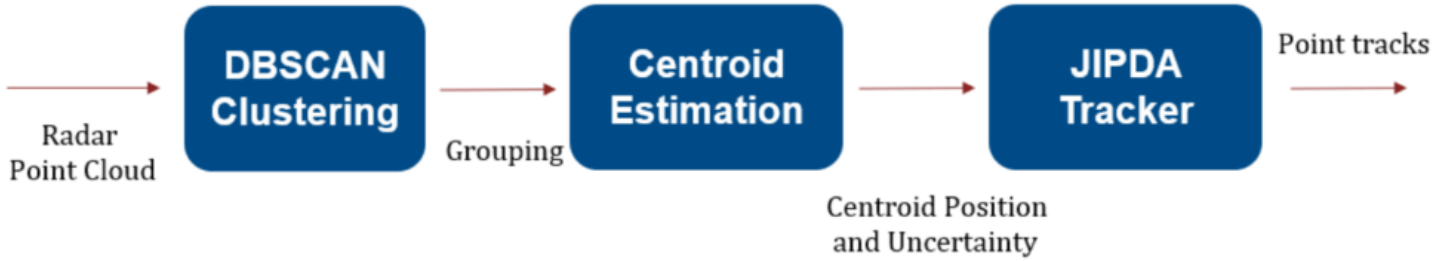
People Tracking Using TI mmWave Radar

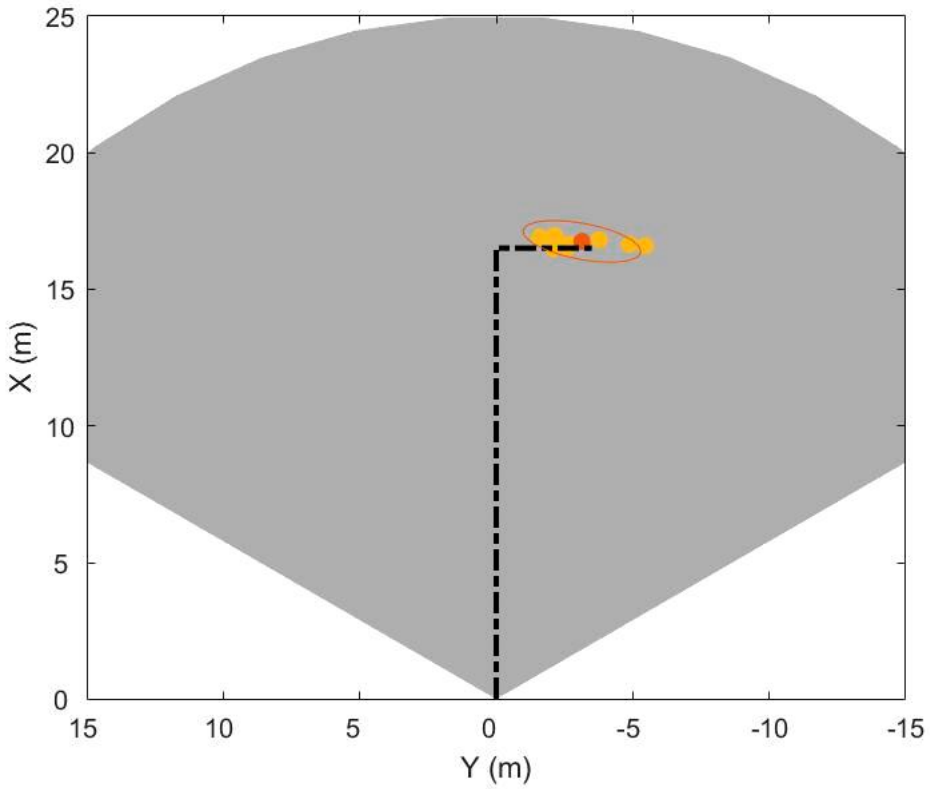


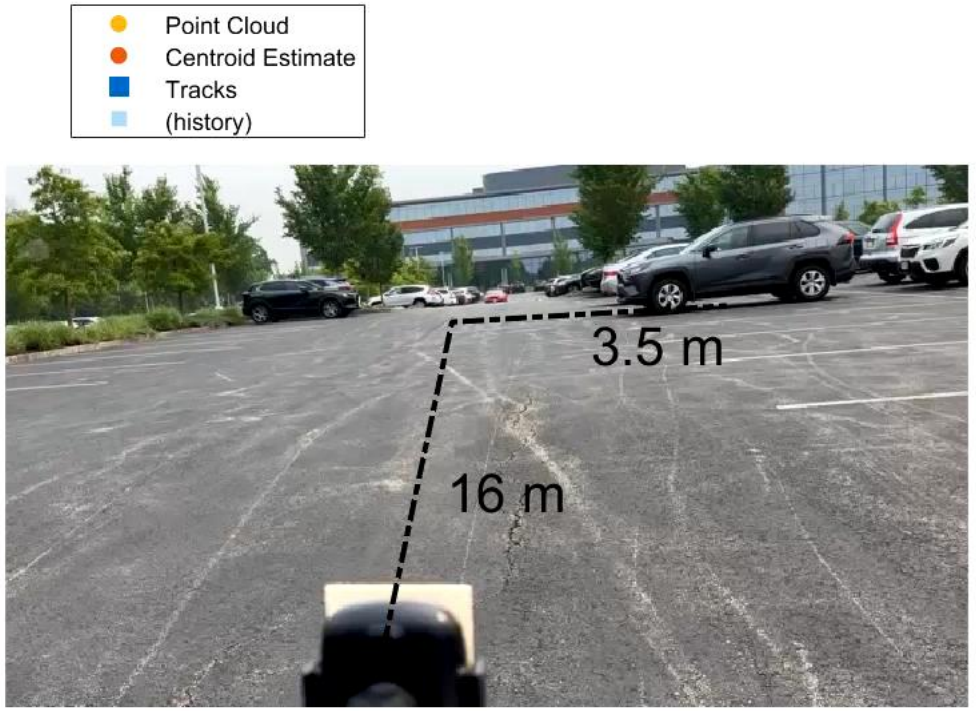




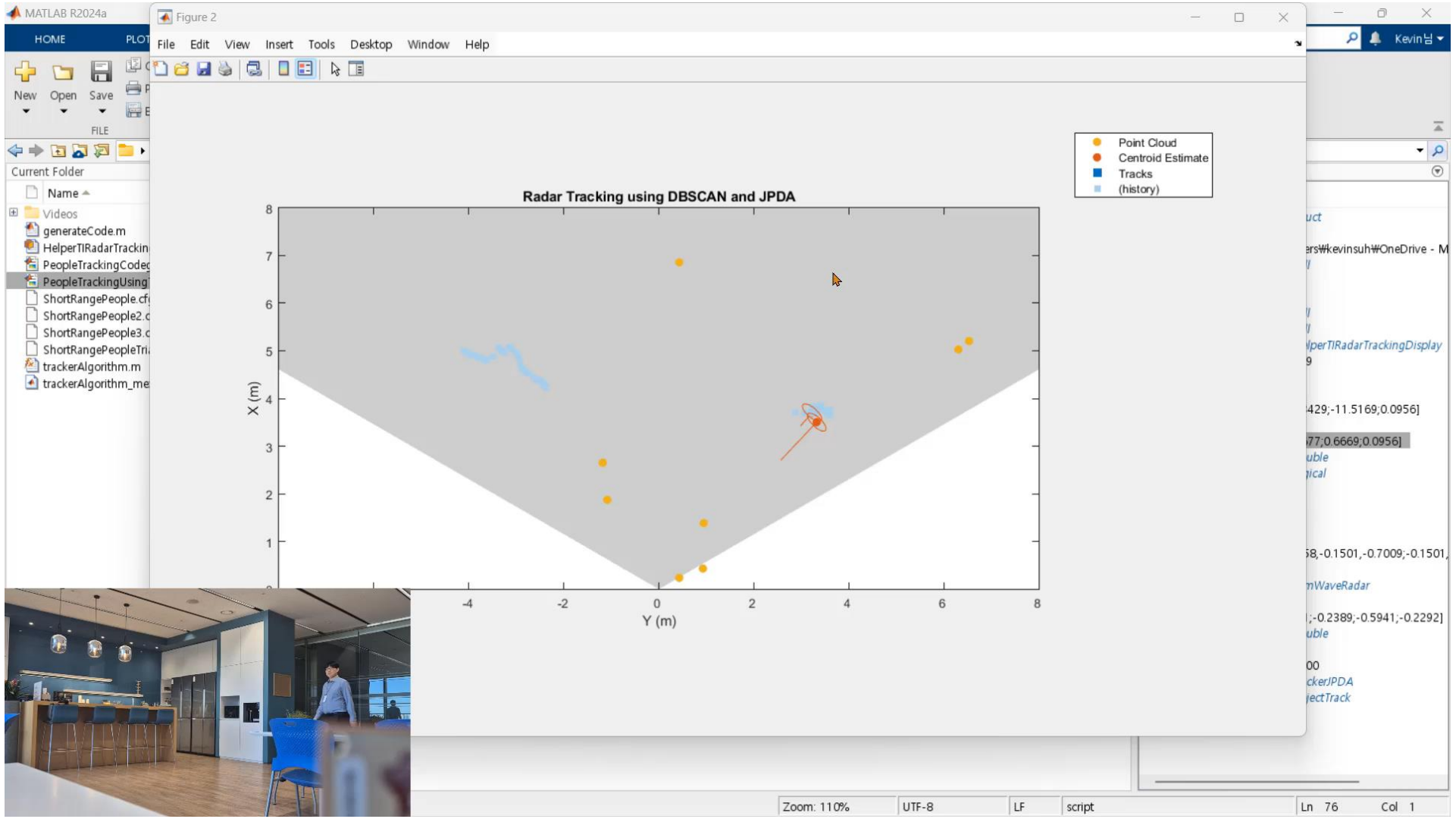
Track Objects in a Parking Lot Using TI mmWave Radar



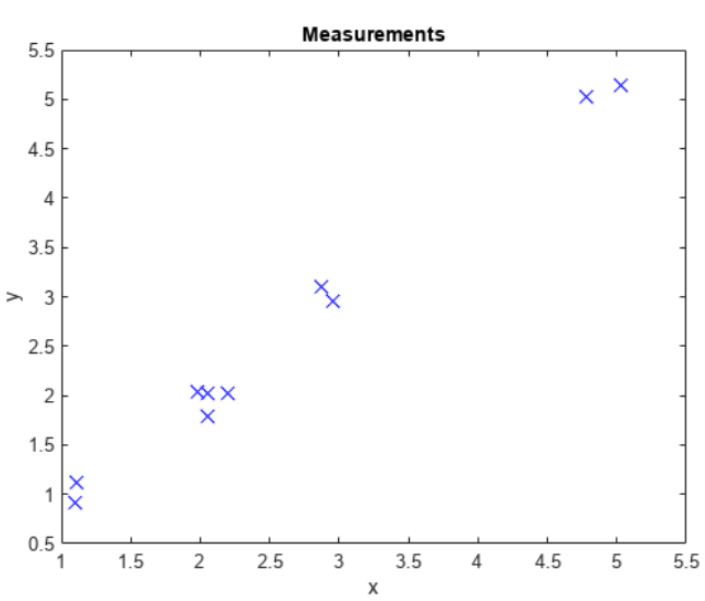


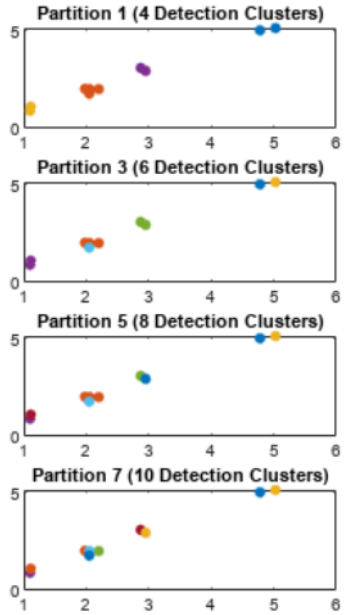


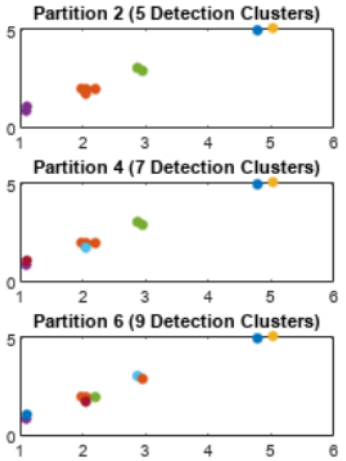
Live Demo at the Demo Booth

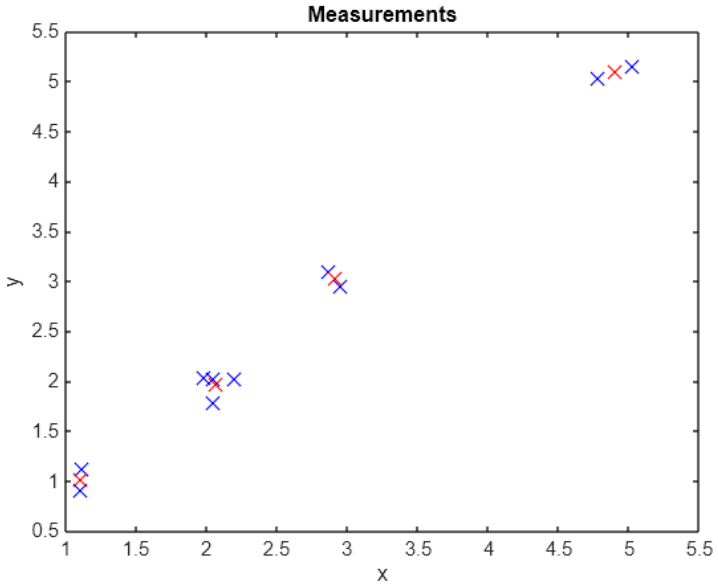


DBSCAN Clustering – Centroid Estimation





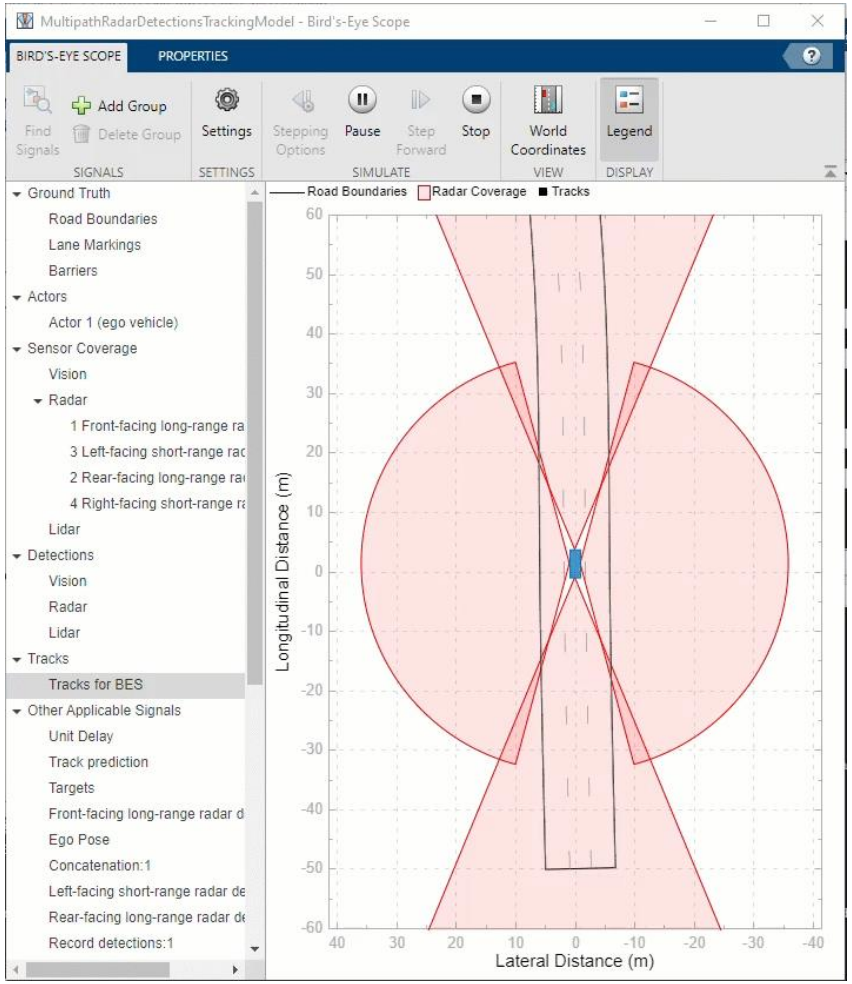


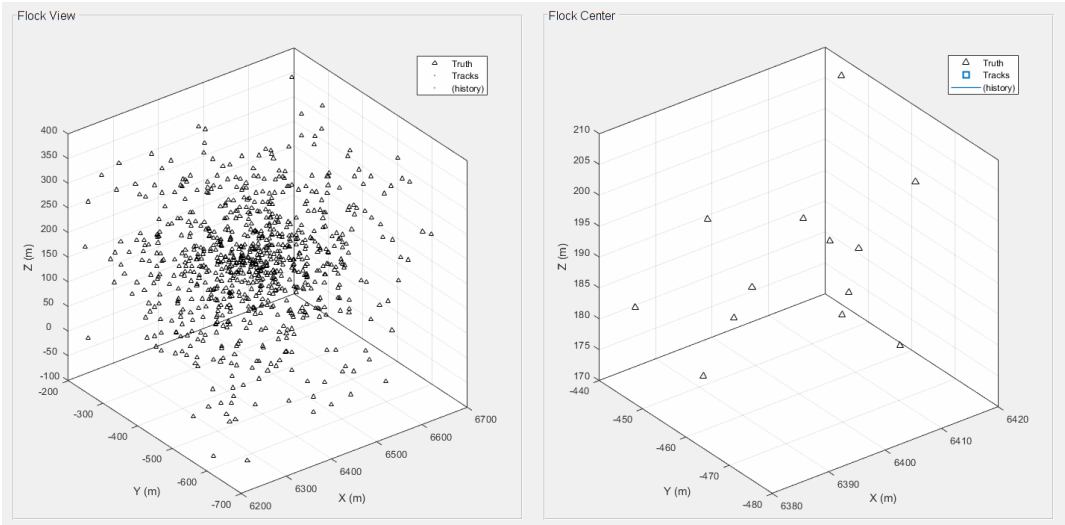


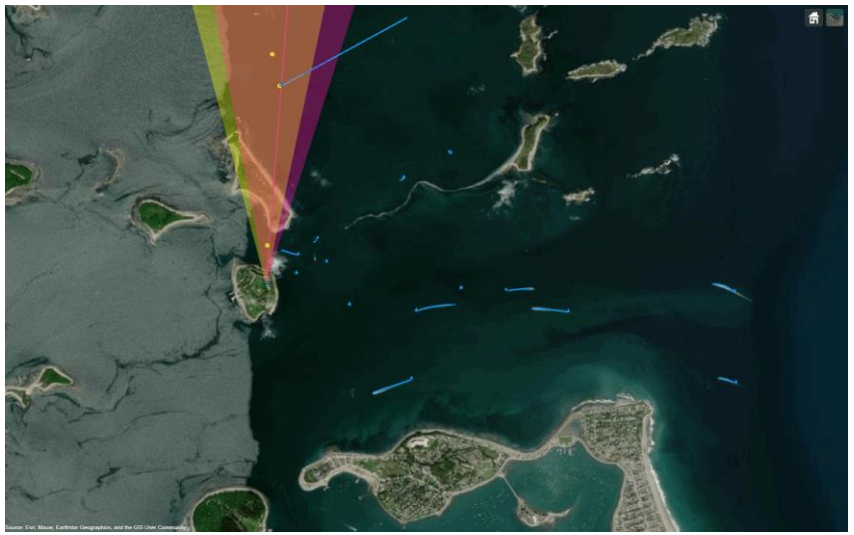
partitionDetections

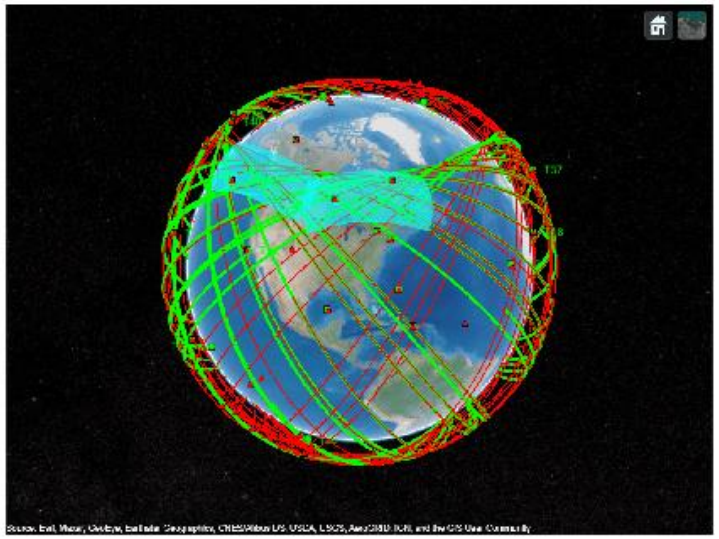
mergeDetections

Trackers for Various Applications









Key Takeaways

Recorded Sensor Data

Scenario Definition and Sensor Simulation

Ownship Trajectory Generation → INS Sensor Simulation

Actors/ Platforms → Radar, IR, & Sonar Sensor Simulation

objectDetection

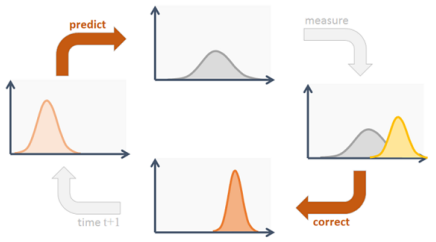
Tracking Algorithms

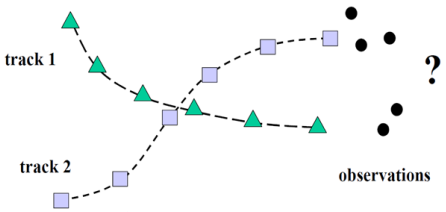
GNN, MHT, etc..

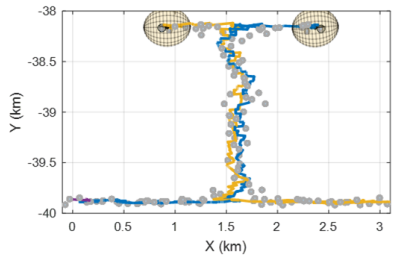
tracks

Visualization & Metrics

A rich library of tracking algorithms







Filters

- Alpha Beta filter
- Kalman filters
  - Linear, EKF, UKF, CKF, MSCEKF
- Particle filter
- Multiple models
  - GSF, IMM

Data Association

- 2D assignment
- S-D assignment
- K-best assignmemt

Trackers

- GNN, JPDA, PHD
- MHT (track-oriented)
- Trackers components
  - History and score logic
  - etc……

Key Takeaways

TI mmWave Radar

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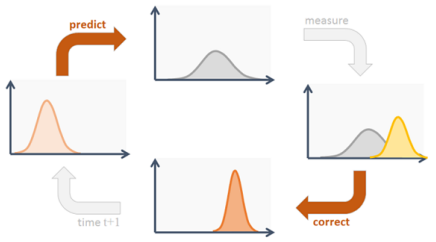

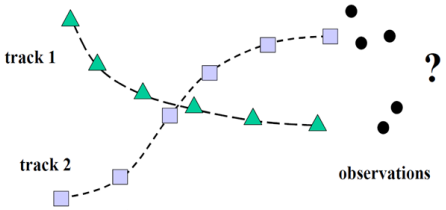

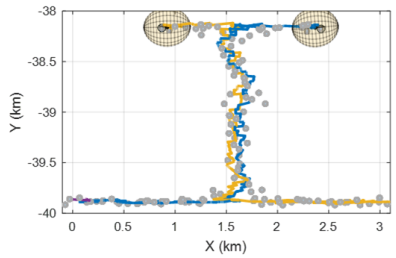

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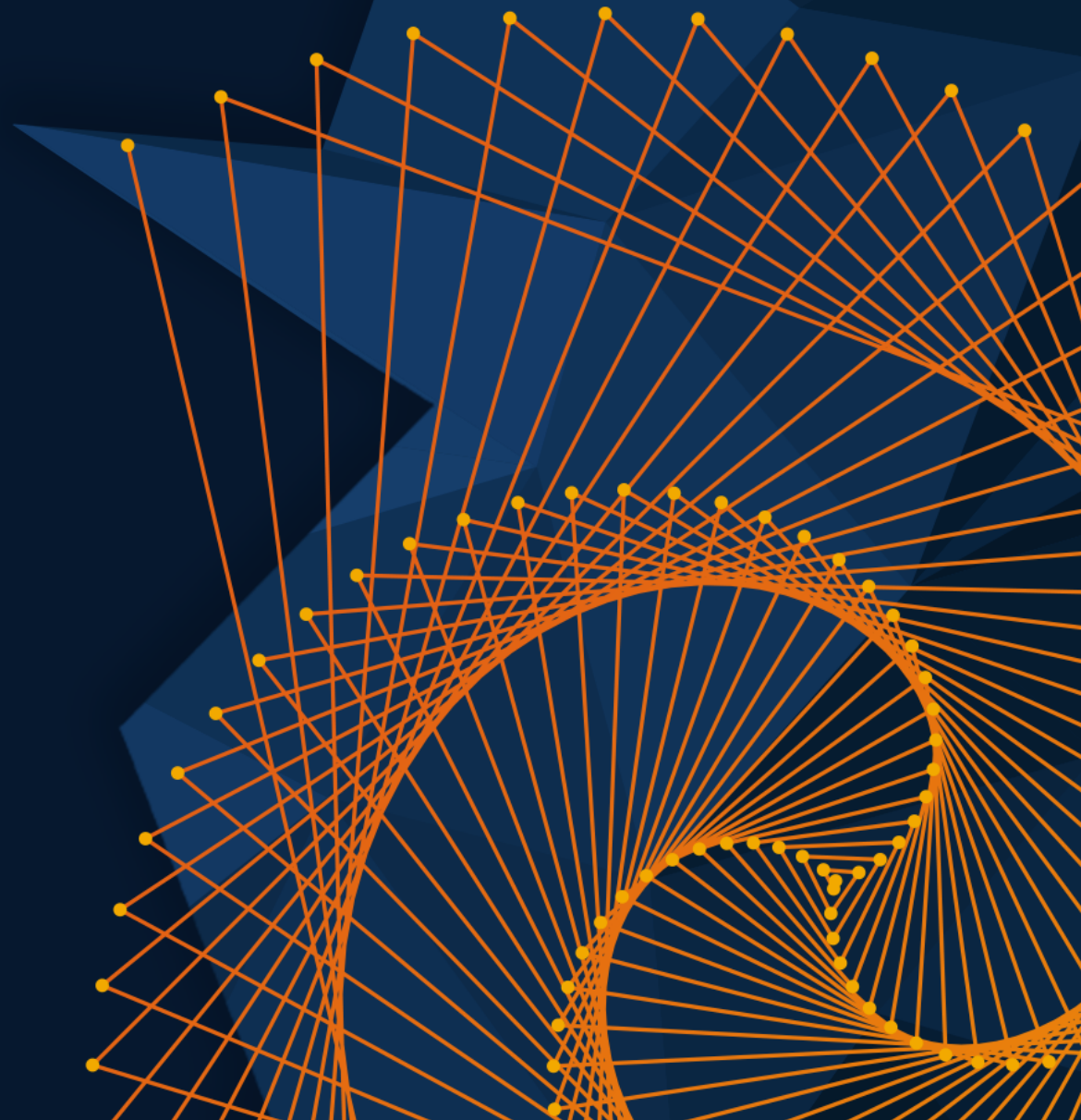
MATLAB EXPO



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