



End-to-end Radar System and Signal Processor Design strategy using MATLAB
Honeywell Technology Solutions Lab

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Introduction

❖ IntuVue RDR-4000 3D Weather Radar System



- Capable of detecting and displaying Wx hazards
- Gimballed System
- Mounted in the nose of the aircraft
- Intercepts hazardous precipitation in flight path

Problem Statement(s) :

How to model Radar System Parameters?

How to quantify radar performance through simulations alone?

What-if analysis.....

- ❖ The radar is mounted in the nose of the aircraft
- ❖ The aircraft flight plan trajectories (purpose/intent)
- ❖ The object of interest can be a cloud, land, sea, moving targets in space
- ❖ The situation is dynamically changing
- ❖ Presence of interfering sources
- ❖ Complexities in the medium through which the EM wave travels

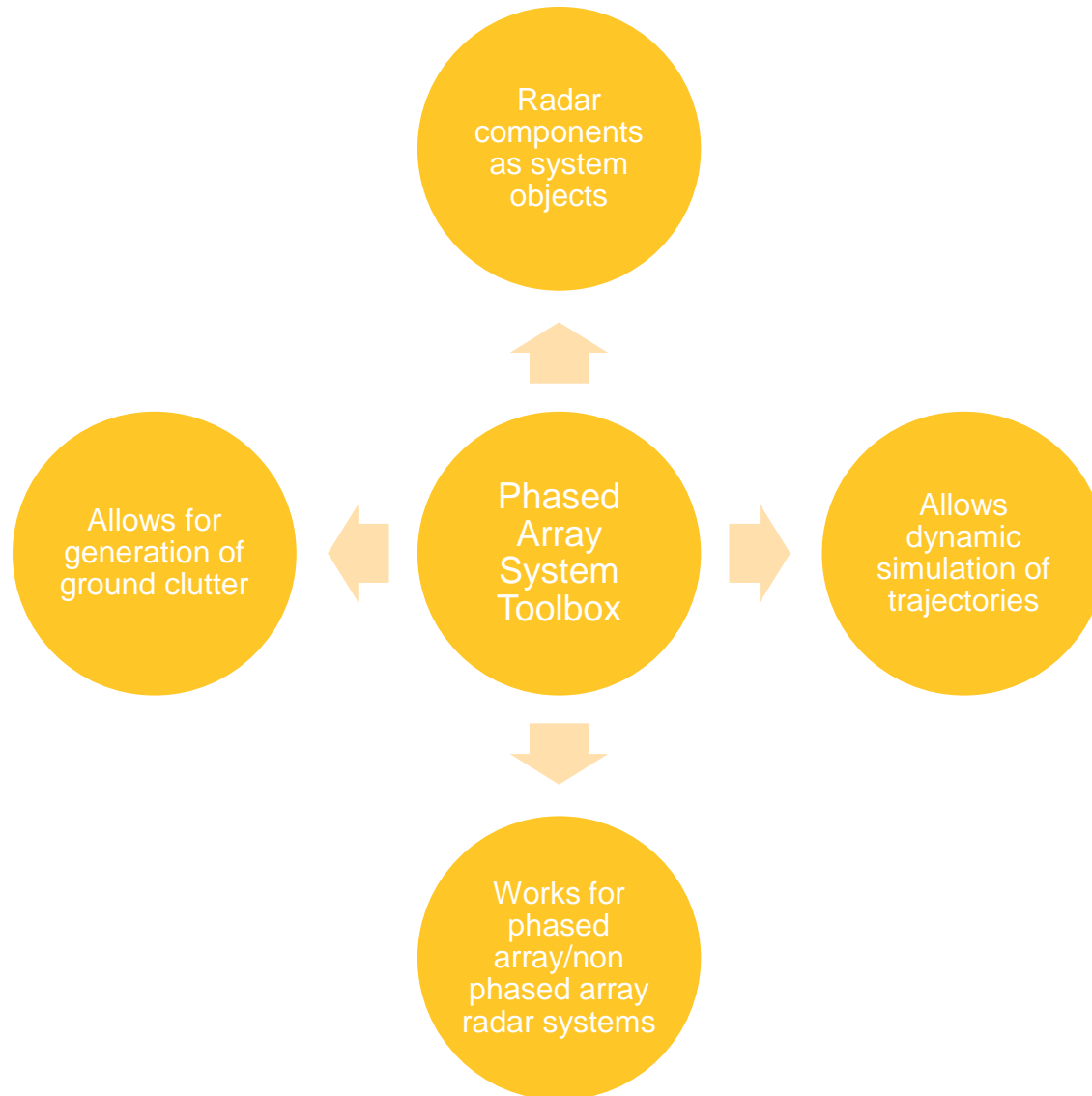
Why do you need to verify airborne radar performance through simulations?

- ❖ Actual Flight sorties are very costly
- ❖ You need to build a prototype radar system through calculations alone (static...)
- ❖ Reduction in cost and time for scratch pad to flight testing
- ❖ Very easy to change system parameters on the fly and perform what..if analysis
- ❖ Ability to generate hazardous situations without flying through them!
- ❖ Ample time afforded to make any system parameter changes based on the simulation outputs

Current Pain Areas



Why MATLAB (Phased Array System Toolbox)?



Dependencies of interest:

- MATLAB
- Phased Array System Toolbox
- Signal Processing Toolbox
- DSP System Toolbox
- Communications System Toolbox
- MATLAB Coder
- Parallel Computing Toolbox
- RF Toolbox

Suggested Generic Design Flow

➤ Generic Design flow can be in 2 parts:

- a. Data generation based on physical scenario
- b. Signal Processing on the data generated in Step 1 above

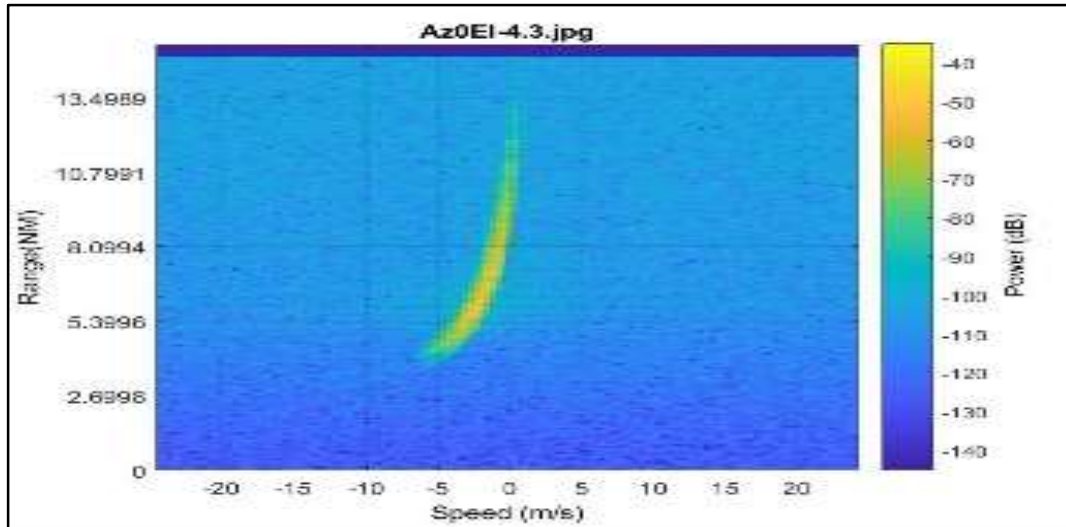
➤ Data Generation:

- a. An actual model of airborne radar is built with phased array system toolbox in MATLAB
- b. Desired aircraft-target (if any) scenario is deployed
- c. The radar is airborne with typical A/c motion parameters
- d. Digital baseband radar data is generated with designed waveforms for the given physical scenario (geometry)
- e. The model is dynamic and changes its state at every time instant (granularity of time is decided based on simulation fidelity and simulation time requirements)

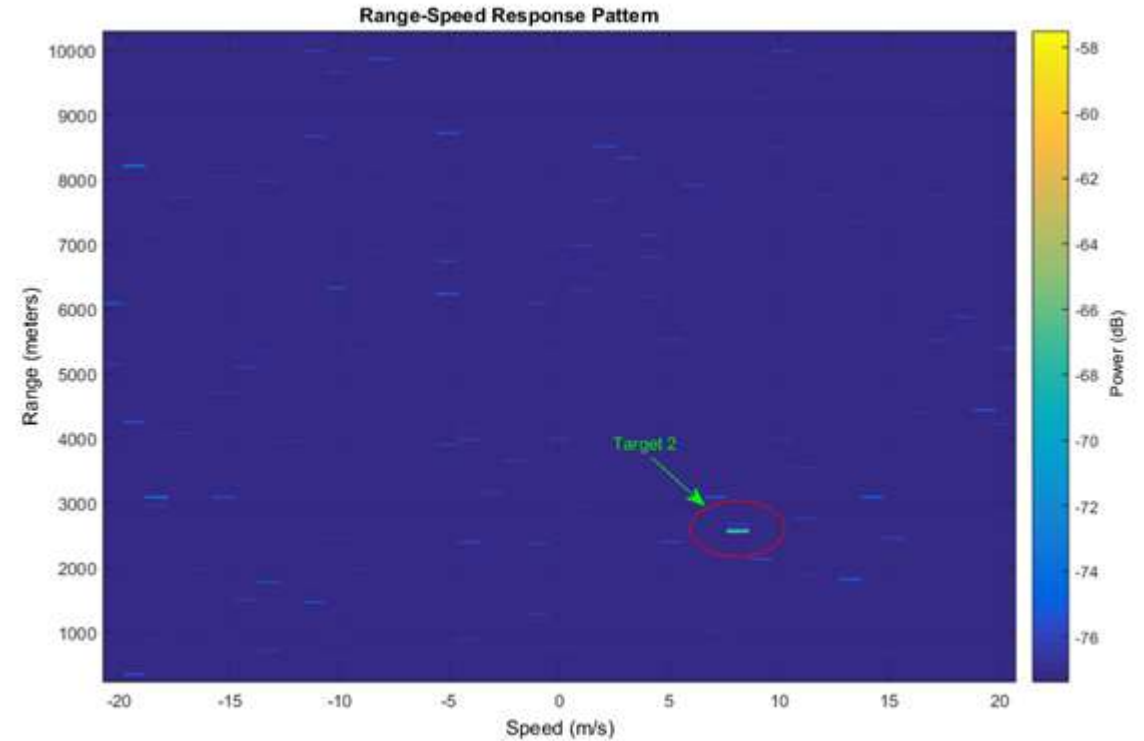
➤ Signal Processing:

- a. The generated radar data (3 dimensional radar data cube) is processed with the designed signal processor to verify the theoretical results with the simulated ones
- b. Signal processor can be fine tuned to get the desired results
- c. Interactive iteration between radar system parameters and signal processing to reach design goals

So what is expected after all ... some examples

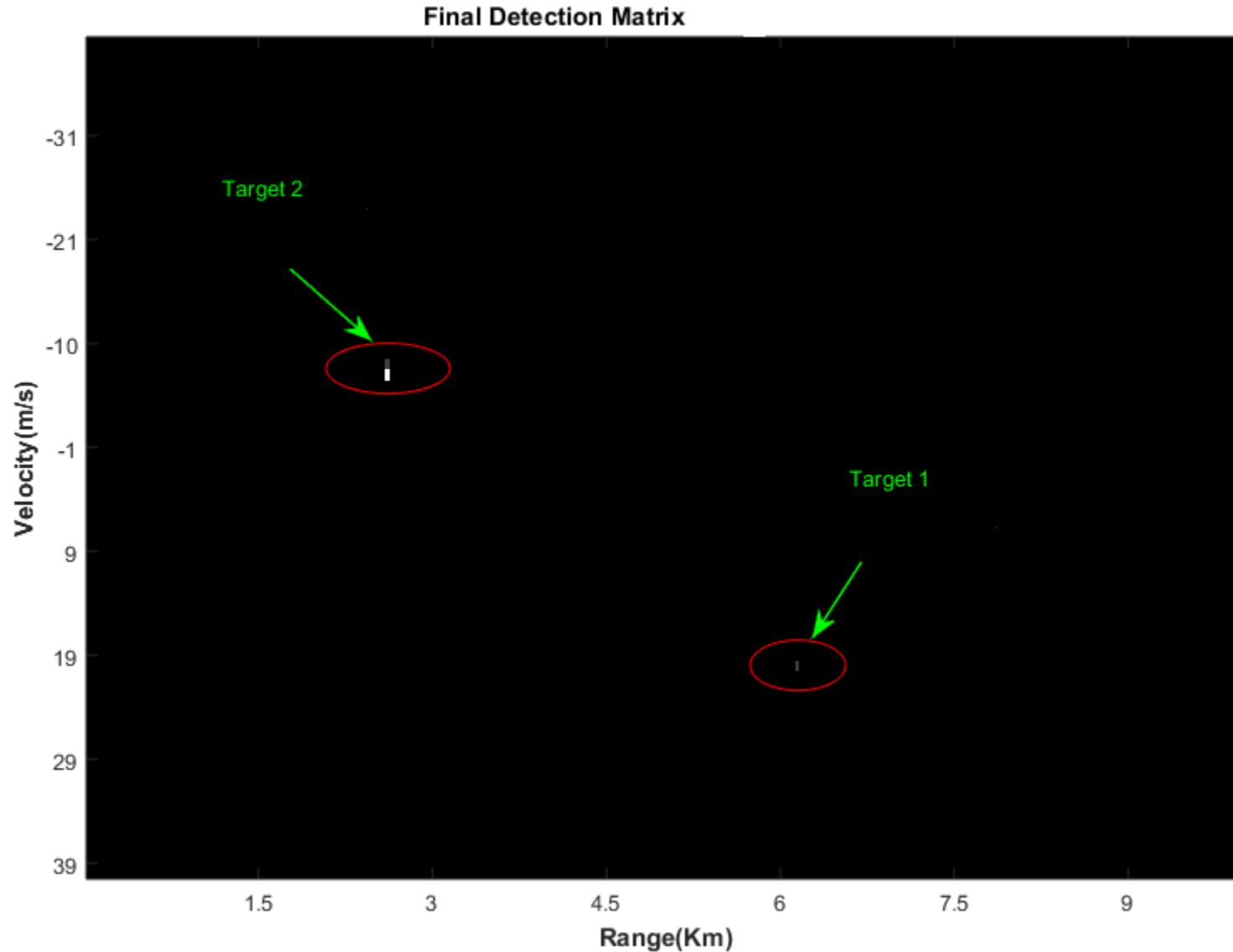


Example airborne ground clutter



A typical Range-Speed Response Pattern

... some more examples (A sample detection matrix)



Benefits

- Multi Domain simulations – easy to pass between teams
- Object Oriented Approach- easy to maintain models and reuse
- Iterative approach to radar system design
- Saves cost and time before actual flight sorties
- Plethora of options to accelerate simulation
- Traditional user friendliness and ease of use by Non SMEs

Further scope of improvement to design flow

- Possibility to integrate legacy codes to models built using phased array system toolbox
- Possibility to inject actual flight data into the models and quantify performance
- Extension to original system objects possible with user defined system objects built for specific needs
- Fully dynamic simulation not only for radar system but also for the host platform
- Addition of RF related impurities to base band data
- Possibility of user defined clutter model definitions

Summary and Conclusion

- Phased Array System Toolbox, a desirable tool for a Radar System designer
- Augments the capability of a radar system designer in making suggestions for a design revamp
- Offers a very convenient way of visualizing the output from a complex device like radar
- Offers a way to iteratively design a radar waveform and signal processing depending on the mode of operation
- The extension to more complicated scenarios/ radar systems is easy as the models are easily scalable
- Offers a convenient method to study design trade-offs
- Ability to improve fidelity by incorporating more details through use of other toolboxes like RF toolbox, Communications System toolbox etc



THANK YOU

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