

Developing ISR Communication Systems Using The MathWorks' Tools

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UAV-based Communications and ISR



Design Objectives

- Increase useable range of UAV from 100 km to 200 km and maintain video performance

Design Approach

- Explore different design alternatives including use of different radio implementations and / or different antenna selections.

System Design Challenges

- Multiple design disciplines
 - Mechanical modeling
 - Communication System modeling
 - Video and Image Processing modeling
- Design Groups working at different locations
 - Work in different facilities / different time zones
- What will happen during the final integration stage?

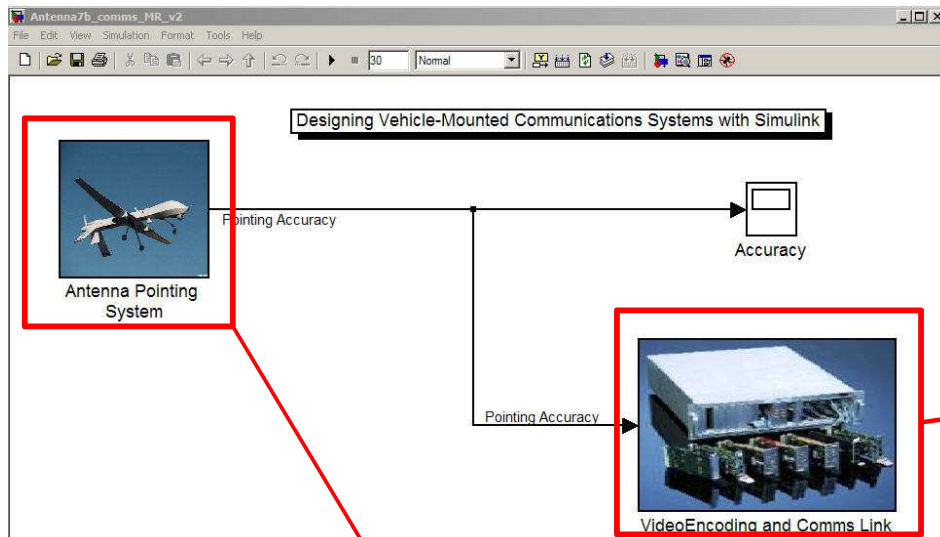
Required System Design Capabilities

- Single Design Environment supporting multiple design disciplines
 - Libraries of pre-built blocks that cover mechanical, communications and video processing design domains
- Continuous Design Verification
 - Single design environment that can be used so as to validate the design at each stage of the design process
- Model Sharing
 - Be able to share models between different teams and locations

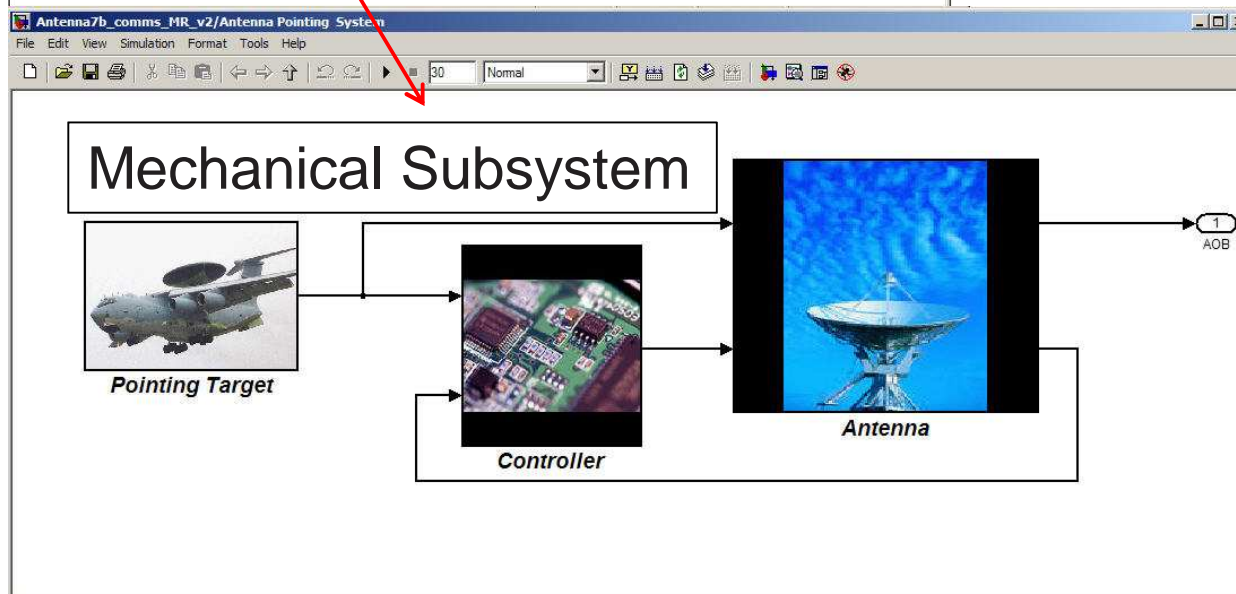
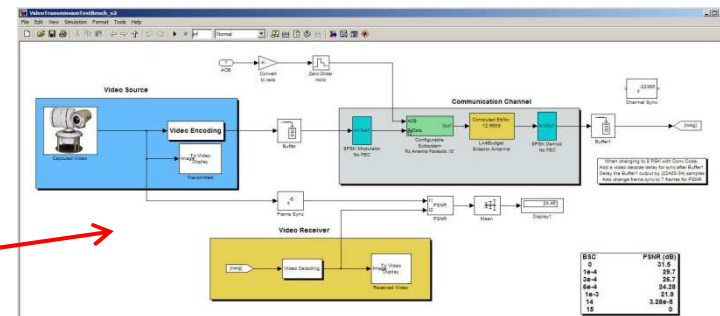
External Factors

- Shrinking development cycles
 - Pressure from customers to develop systems in a shorter time frame with superior performance.
- Growing Design Complexity
 - Vehicles and other related equipment need to have more functionality than ever before.

UAV Demonstration

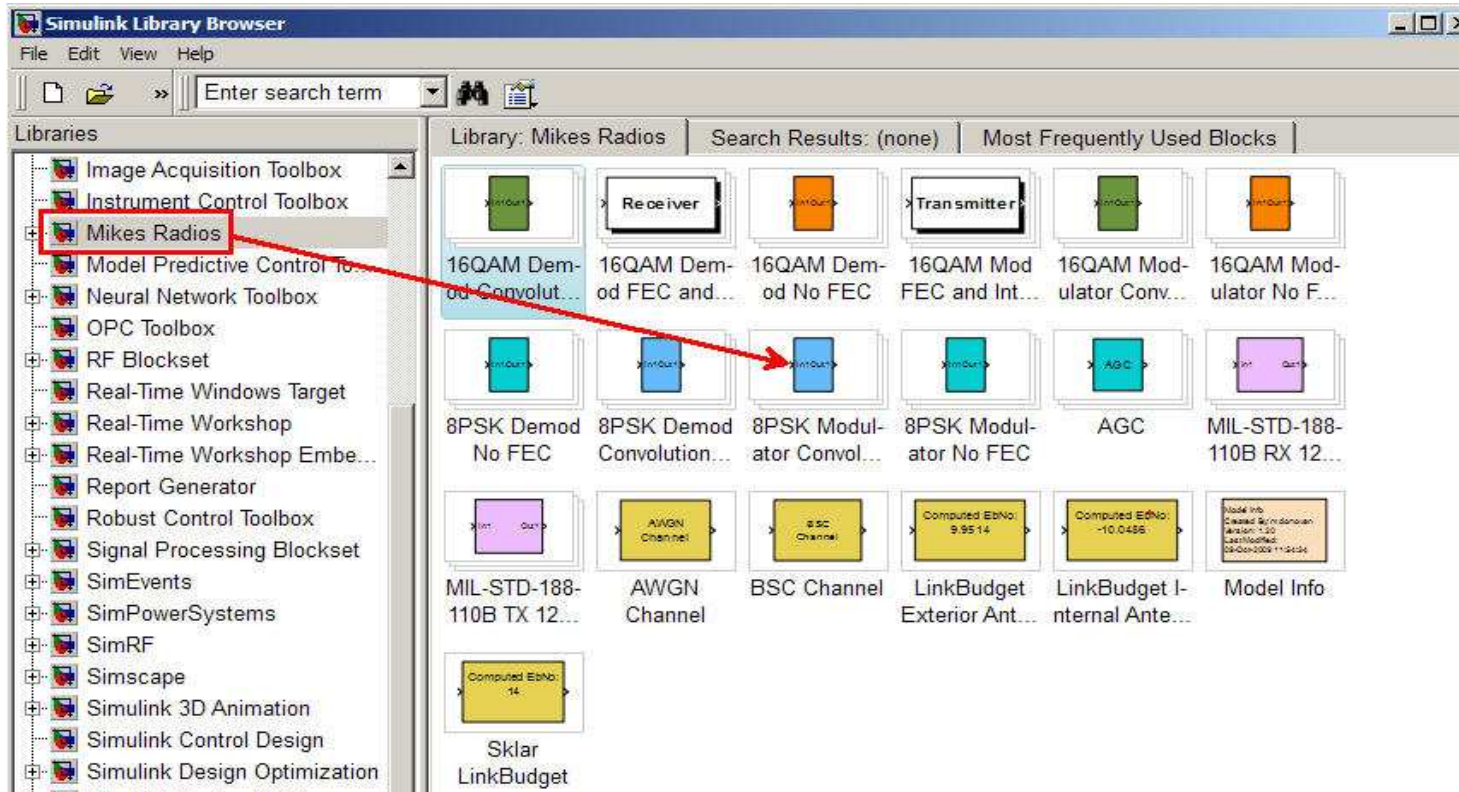


Communications + Video Imaging Subsystem



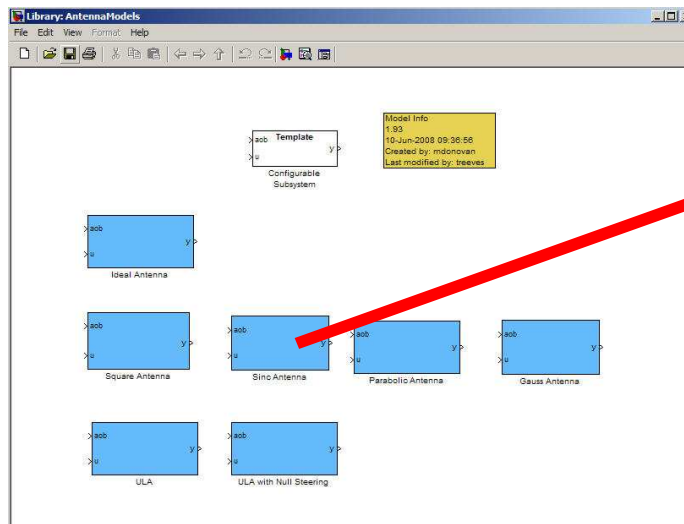
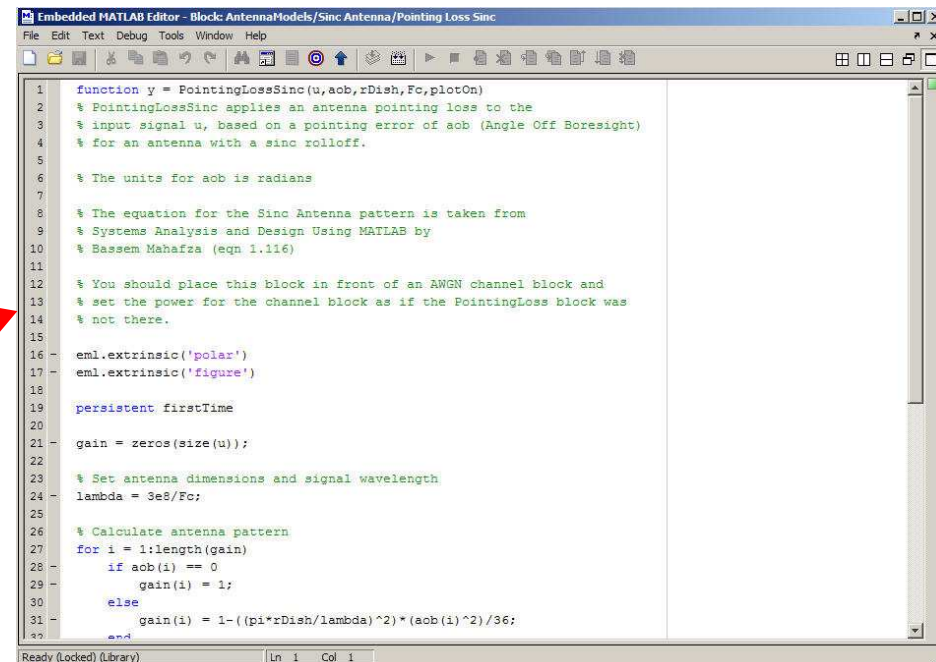
Custom Libraries

- Allows others access to custom Simulink subsystems that you have developed
- Repository of models that you or your colleagues can use in future designs



Embedded MATLAB Function Block

- Fast execution
- Generates C code (with Real-Time Workshop®)
- Multiple input and output ports
- Modular code: multiple blocks
- Integrated editor

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Embedded MATLAB Editor - Block: AntennaModels/Sinc Antenna/Pointing Loss Sinc
File Edit Text Debug Tools Window Help
1 function y = PointingLossSinc(u,aob,rDish,Fc,plotOn)
2 % PointingLossSinc applies an antenna pointing loss to the
3 % input signal u, based on a pointing error of aob (Angle Off Boresight)
4 % for an antenna with a sinc rolloff.
5
6 % The units for aob is radians
7
8 % The equation for the Sinc Antenna pattern is taken from
9 % Systems Analysis and Design Using MATLAB by
10 % Bassem Mahafza (eqn 1.116)
11
12 % You should place this block in front of an AWGN channel block and
13 % set the power for the channel block as if the PointingLoss block was
14 % not there.
15
16 eml.extrinsic('polar')
17 eml.extrinsic('figure')
18
19 persistent firstTime
20
21 gain = zeros(size(u));
22
23 % Set antenna dimensions and signal wavelength
24 lambda = 3e8/Fc;
25
26 % Calculate antenna pattern
27 for i = 1:length(gain)
28     if aob(i) == 0
29         gain(i) = 1;
30     else
31         gain(i) = 1 - ((pi*rDish/lambda)^2) * (aob(i)^2) / 36;
32     end
33 end
    
```

End Results

| Design Challenge | Solution |
|--|--|
| Design and verify communications subsystem | - model different communications schemes using a library of Radio Models |
| Design and verify Video compressions | Use Video and Image Processing Blocksets to model video algorithms |
| Access impact of antenna selection | Incorporate MATLAB antenna models in Simulink model using Embedded MATLAB |
| Access impact of stabilization system | Model antenna gimbal and controller with SimMechanics |
| Integrate systems in simulation | Use Simulink to integrate multiple domains into single system level model |
| Optimize design at a system level | Model a number of different design alternatives as well as key parameters such as maximum operating distance |

Next Steps

- Incorporate this model into a broader system simulation
 - flight dynamics
 - target tracking

Products Used

- Simulink
 - Embedded MATLAB blocks
- Video and Imaging Processing Blockset
 - Segmentation, motion estimation, morphology and more
- Communications Blockset
 - Source coding, error correction, modulation and more
- Signal Processing Blockset
 - Estimation, filtering, linear algebra, statistics, FFT, and more
- SimMechanics
 - Physical Modeling