What's New in MATLAB and Simulink for Signal Processing?

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Signal Processing
Harmonic and Intermodulation Distortion Measurement

Industry-standard metrics
- Signal to Noise Ratio (SNR)
- Total Harmonic Distortion (THD)
- Signal to Noise and Distortion Ratio (SINAD)
- Third Order Intercept (TOI)

Harmonic labeling

```matlab
load sineex
snr(x,Fs)
ans =
   97.907030943375275
```
designfilt launches Filter Design Assistant if needed:

- Runtime error recovery
- Automatic code correction
- Teaches you how to properly specify filters
ARM Cortex-M CMSIS Code Generation

- Optimized ARM Cortex-M CMSIS library code replacement support for key DSP algorithm system objects and blocks
- FIR filter example: Generated C code, invoking ARM CMSIS library, 10x faster than standard code generation
- Examples provided in the DSP System Toolbox ARM Cortex-M CMSIS support package
Scopes easily let you inspect and log data at run-time.

MATLAB

```matlab
>> hSA = dsp.SpectrumAnalyzer(...
    'SampleRate',10e3);
>> ... 
>> step(hSA, x);
```
Spectrum Analyzer Enhancement

Spectrogram View

- Read and compare values on the Spectrogram in Spectrum Analyzer
- Auto-magnifier under cursor position

Interactive tools

- Complimentary Cumulative Distribution Function (CCDF)
- Instantaneous power distribution
- Adjacent Channel Power Ratio (ACPR)
- Harmonic & Intermodulation distortions
Automatic Generation of DSP Test Benches

The UI lets you choose sources,

- Real-time audio
- Audio from file
- Synthetic signals
- ...

and sinks,

- Audio playback
- Time scope
- Spectrum analyzer
- ...

» HelperGenDSPTestbenchUI
Communications
OFDM System Objects & Blocks

Modulating and demodulating signals with OFDM technology

- MIMO support
- Data and pilot signal packing
- Windowing to avoid spectrum regrowth
- Visualization for subcarrier mapping
- Providing I/O signal size information

Examples:
» OFDMSynchronizationExample
» commwlan80211a.mdl
» commdvbt.mdl
New Blocks and System objects

- Rayleigh Channel System object
- Rician Channel System object
- MIMO Channel Block
- Sphere Decoder Block
- Constellation Diagram Block

```
>> comm.RayleighChannel
ans =
    System: comm.RayleighChannel
    Properties:
    SampleRate: 1
    PathDelays: 0
    AveragePathGains: 0
    NormalizePathGains: true
    MaximumDopplerShift: 0.001
    DopplerSpectrum: [1x1 struct]
    RandomStream: 'Global stream'
    PathGainsOutputPort: false
```
PSK and QAM Frequency Offset Estimators

Perform coarse, open-loop frequency synchronization for SDR applications

- QAM: Maximum Likelihood estimation
- PSK: Maximum Likelihood or correlation-based estimation
- Especially relevant for SDR applications

`doc comm.PSKCoarseFrequencyEstimator`
`doc comm.QAMCoarseFrequencyEstimator`
- Run the examples
HDL Optimized FFT/IFFT

- Pipelined Radix-2 FFT/IFFT
- Streaming data applications
- For simulation, vector input can be used
Support Package for Xilinx FPGA-Based Radio

Design and prototype Xilinx FPGA-based software-defined radio (SDR) systems

- I/O peripheral for streaming RF signals
- Configurable filters and sample rate conversion on FPGA
- Customizing FPGA using HDL Coder (Xilinx ISE® Design Suite required)

Examples:
- Frequency Offset Calibration Transmitter
- Frequency Offset Calibration Receiver
- FRS/GMRS Walkie-Talkie Receiver
- QPSK Transmitter
- QPSK Receiver
Support Package for RTL-SDR

Design and prototype

RTL-SDR software-defined radio systems

- I/O peripheral for streaming RF signals
- NooElec™ NESDR Mini USB Stick (R820T) & Nano USB Stick (R820T) SDR devices with frequency range 30MHz – 1.8GHz

Examples:
- FM Mono / Stereo
- FRS Receiver
- Spectral Analysis
- Frequency offset calibration
- (Soon) Airplane flight-path display demo
LTE System Toolbox

- Modulation: \texttt{lteSymbolModulate}
- Demodulation: \texttt{lteSymbolDemodulate}
- Scrambling: \texttt{ltePDSCHPRBS}
- Layer Mapping: \texttt{lteLayerMap}
- Layer Demapping: \texttt{lteLayerDemap}
- Precoding: \texttt{lteDLPrecode}
- Deprecoding: \texttt{lteLayerDeprecode}

Complete PDSCH processing:
- Encoding: \texttt{ltePDSCH}
- Decoding: \texttt{ltePDSCHDecode}

Resource indices: \texttt{ltePDSCHIndices}

Precoding Matrix Indication:
- \texttt{ltePMISelect}
- \texttt{ltePMInfo}
- \texttt{lteCSICodebook}

Resource Mapping:

Fine

Mid-level
Phased Array Systems
Phased Array Systems

Waveform Generator

Waveform design and analysis

Transmitter

Signal modeling framework

Transmit Array

Phased array design and analysis

Environment, Targets, and Interference

Signal Processing

Temporal processing
Spatial processing
STAP

Receive Array
Code Generation Support

- Full codegen support
- Improved simulation performance

Example:

```matlab
function [out1, out2] = fBeamscanEstimator(x)
    ula = phased.ULA(10);
    doa = phased.BeamscanEstimator('SensorArray', ula, ...
                                  'DOAOutputPort', true);
    [out1, out2] = step(doa, x);

fBeamscanEstimator.m

Example:

%% Accelerating simulation through code generation
x = sensorsig(-2.25:0.5:2.25, 1,[10; 0], db2pow(-10));
%Generate code and compile function
codegen fBeamscanEstimator -args {x}
%Run the MATLAB version
tic;
[out1_ml, out2_ml] = fBeamscanEstimator(x);
%Run the compiled version
[out1_cg, out2_cg] = fBeamscanEstimator_mex(x);
```
Enhancements in Sensor Array Analyzer

Arbitrary Geometry

- Custom 2D Directivity Cuts
- Arbitrary Geometry Array
- Custom Antenna Element
- Custom Tapers
SimRF

Faster loading and simulation for Circuit Envelope models

New blocks

- Circulator, Divider and Coupler blocks
- Ideal Delay-based Transmission Line block
Mixed Analogue/Digital Simulations

Find this example and many more in the mixed-signal library (MATLAB Central)
Image Processing & Computer Vision
Color Thresholder App
Color Thresholder App
Face Detection and Tracking