Algorithmenentwurf leicht gemacht: Neuigkeiten in der Signalverarbeitung in MATLAB

MATLAB EXPO 2015
DEUTSCHLAND

Marco Roggero
Senior Application Engineer
Key Takeaways

System Objects:

- can accelerate your MATLAB code
- are very easy to create, configure and execute
- support floating and fixed-point data types as well as automatic C/C++ and HDL code generation
Working with System Objects

Command Window

```
>> Audiofilereader = dsp.AudioFileReader

Audiofilereader =

System: dsp.AudioFileReader

Properties:
    Filename: 'C:\MATLAB\2015a\toolbox\dsp\dsp\speech_dft.mp3'
    PlayCount: 1
    SampleRate: 22050
    SamplesPerFrame: 1024
    OutputDataType: 'double'
```
How to create test bench in MATLAB

```matlab
%% Create and Initialize
SamplesPerFrame = 1024;
Fs = 44100;

Microphone = dsp.AudioRecorder('SamplesPerFrame', SamplesPerFrame);
Spectra = dsp.SpectrumAnalyzer ('SampleRate', Fs);

%% Stream processing loop

tic;
while toc < 20
    % Read frame from microphone
    audioIn = step(Microphone);

    % View audio spectrum
    step(Spectra, audioIn);
End

%% Terminate
release(Microphone)
release(Spectra)
```
Batch processing

All the data

Work on all the data at once…

Deliver all at once
Systems Objects enable stream processing

- Each frame available as soon as processed
  - Reduced memory footprint
  - Near real-time / Life analysis
- Typical applications
  - Communications Systems
  - Audio / video signal processing
  - Data acquisition
Stream processing in MATLAB

- **Streaming techniques** process continuous data from a captured signal or large file by dividing it into “frames” and fully processes each frame before the next one arrives
  - Memory efficient

- Streaming algorithms in DSP System Toolbox provide
  - Implicit data buffering, state management and indexing
  - Simulation speed-up by reducing overhead
Where to find System Objects?

- DSP System Toolbox
- Computer Vision System Toolbox
- Phased Array System Toolbox
- Communications System Toolbox
Antenna Toolbox
Released with 2015a version

Antenna library elements
------------------------
dipole - Creates a strip dipole on the Y-Z plane
dipoleFolded - Creates a folded dipole antenna
dipoleVes - Creates a V-dipole antenna
bowtieTriangular - Creates a planar bowtie antenna on the Y-Z plane
bowtieRounded - Creates a rounded bowtie dipole on the Y-Z plane
monopole - Creates a monopole over a rectangular ground plane
monopoleTopHat - Creates a capacitively loaded monopole over a rectangular ground plane
invertedF - Creates an inverted-F antenna over a rectangular ground plane
invertedL - Creates an inverted-L antenna over a rectangular ground plane
loopCircular - Creates a circular loop on the X-Y plane
loopRectangular - Creates a rectangular loop on the X-Y plane
spiralArchimedean - Creates an Archimedean spiral antenna on the X-Y plane
spiralEquiangular - Creates an equiangular spiral antenna on the X-Y plane
helix - Creates a helix antenna on a circular ground plane
yagiUda - Creates a Yagi-Uda array along the Z-axis
cavity - Creates a cavity backed antenna
reflector - Creates a reflector backed antenna
patchMicrostrip - Creates a rectangular microstrip patch antenna
slot - Creates a rectangular slot antenna on a ground plane
pifa - Creates a planar inverted-F antenna on a rectangular ground plane
vivaldi - Creates a vivaldi notch antenna on a rectangular ground plane
Signal processing example for algorithm’s performance comparison
Compare algorithm execution time with different implementations:

<table>
<thead>
<tr>
<th>Versions of the Algorithm</th>
<th>Elapsed Time (sec)</th>
<th>Acceleration Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Traditional MATLAB functions</td>
<td>18.0953</td>
<td>1.0000</td>
</tr>
<tr>
<td>2. System Objects in-lieu of MATLAB functions</td>
<td>3.6914</td>
<td>4.9020</td>
</tr>
<tr>
<td>3. MATLAB Coder MEX version</td>
<td>1.5241</td>
<td>11.8725</td>
</tr>
</tbody>
</table>
Accelerating algorithm execution

- Pre-allocation and vectorization
- Pre-defined efficient implementations of algorithms
- Generate MEX files automatically with MATLAB Coder
- Parallel computations on multicore computers, GPUs, and clusters
Options to speeding up MATLAB algorithms:

- Toolbox Functions
- Toolbox Functions + PCT (parfor)
- System Objects
- System Objects + PCT (parfor)
- System Objects + Code Generation
- System Objects + Code Generation + PCT (parfor)

Maximum-Likelihood Equalizer
Voice Pitch Estimation
DCT-based Image Compression

PCT: Parallel Computing Toolbox
Dual core machine used for this example

Faster
Why Engineers translate MATLAB to C today?

Integrate MATLAB algorithms w/ existing C environment using source code and static/dynamic libraries

Prototype MATLAB algorithms on desktops as standalone executables

Accelerate user-written MATLAB algorithms

Implement C code on processors or hand-off to software engineers
Automatic code generation and System Objects

C/C++ code Generation supported for nearly all System Objects of DSP, Communication and Computer Vision System Toolboxes

Support of floating and fixed-point data types

Code Replacement libraries enable generation of target optimized embedded C code

Large library of System Objects supported from HDL code generation
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