MATLAB EXPO 2015
KOREA
2015년 5월 21일 목요일
인터컨티넨탈 코엑스, 서울
웨어러블 디바이스의 신호분석

Senior Application Engineer
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Agenda

- Internet Of Things

- Signal Analytics and Classification
  : On data from wearable and mobile device

- Heart rate monitoring
  : From algorithms to prototyping on ARM® hardware
Internet of Things?
Internet of Things!

- Application Integration
- Data Collection
- Analytics
- Visualization
- Security
Technologies Enabling IoT

- Low-cost low-power sensors and actuators
  - Data validation and clean-up
  - Smart control techniques
- Ubiquitous connectivity
  - Wired / wireless communication
- Data aggregation and analysis
  - “Big data”
Components of IoT

- Edge Nodes:
  - Local embedded algorithms
  - Data reduction

- Data Aggregator:
  - Online analytics
  - Visualization and reporting

- Connectivity:
  - Deploy analytics to aggregator
  - Deploy algorithm to device

- Exploratory Analysis:
  - Historical analytics
  - Algorithm development
MathWorks Support

Data Aggregator
- Online analytics
- Visualization and reporting

Edge Nodes
- Local embedded algorithms
- Data reduction

Communication
Deploy algorithm to device
Deploy analytics to aggregator

Connectivity

Exploratory Analysis
- Historical analytics
- Algorithm development
MATLAB Mobile

Connect to MathWorks Cloud
Run MATLAB commands any time you have Internet access.

Connect to Your Computer
Access your data and programs when you are on the same network as your computer.

You can change the connection at any time from the Settings tab.

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“There are already more Internet-connected devices on the planet than people, and industry experts predict that the number of connected devices for the IoT will top 15 billion nodes by 2015 and reach 50 billion nodes by 2020. Many of those nodes will require energy-friendly ARM-based MCUs and wireless systems-on-chip (SoCs) designed to achieve current consumption as low as 100 µA per megahertz.” – Tyson Tuttle, CEO, Silicon Labs
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Challenges with Signal Analytics

- Data analytics on sensor signals
- Need domain-specific knowledge
- Open-ended problem and long discovery cycles
- You can use offline pre-recoded training and validation data sets
Example: Human Kinetic Activity Analysis/Classification

Dataset courtesy of:
http://archive.ics.uci.edu/ml/datasets/Human+Activity+Recognition+Using+Smartphones
Human Kinetic Activity Analysis/Classification Solution

- Only core built-in Signal Processing algorithms
- 66 high-quality features extracted with only 65 lines of code!
- Visualization and automation accelerate insight iterations
Leverage built-in algorithms
Do you want to re-invent the wheel?

- **Signal Processing Toolbox 7.0**
  - Simplified interface and examples for casual users
  - Analysis of non-evenly sampled data (IoT)
  - New functions for signal measurements, filter design

- **Neural Network Toolbox**

- **Statistics & Machine Learning Toolbox**

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Summary
MATLAB for Signal Analytics

- Signal Processing Toolbox has an extensive set of functions for signal processing and analysis
- Visualisation and App-driven automation accelerate insight iterations
- All this comes with compact & concise MATLAB language and extensive documentation
- Applicable to Internet-of-Things (IoT) projects
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Challenges with streaming DSP

- Stream real-world data into and out of MATLAB
- Algorithms must keep up with rate of incoming frames of data
- Need domain-specific knowledge for both algorithms and data I/O

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Example: Smart Sensor for Heart Rate Monitoring

Acquire streaming sensor data (ECG) in real-time with BeagleBone Black (BBB) using ARM Cortex-A

Streaming algorithms: filtering, sample rate conversion, detection and classification in real-time

Prototype: Test algorithms using External-mode

Implement and deploy on ARM Cortex-A BBB board

Real-time Sensor Data Capture
Streaming Signal Processing
Test/Validate
Deploy/Implement
Smart Sensor for Heart Rate Monitoring Solution

- A Model-Based Design Workflow
- Executable specification & simulation: pre process, filter & detect ECG Signal
- Code Generation: Create a PIL block with optimized code on ARM Cortex-A processor
- Verification: Perform real-time processing with BeagleBone Black
Streamlined Workflow: from Algorithms in MATLAB and Simulink to Prototyping

**DESIGN and SIMULATE**
- Algorithm Development
- Streaming signal Processing
- Floating Point

**IMPLEMENT and INTEGRATE**
- C, C++
- Fixed-Point
- VHDL, Verilog
- ARM
- DSP
- FPGA
- ASIC

**TEST and VERIFY**

Quick design and faster simulation for real-time DSP systems:
- Streaming Signal Processing in MATLAB
- Signal Processing in Simulink
- Single and Multirate FIR/IIR Filter Design, and Adaptive Filters
- Signal Scopes, Analyzers, and Measurements
- Real-Time Multichannel Audio Processing and I/O

Rapid prototyping with streamline test and verification:
- C and C++ Code Generation for Desktop Acceleration and Deployment
- Implementation and Integration for FPGA, ASIC, DSP and ARM
ARM Cortex-A Ne10 Library Support from DSP System Toolbox with MATLAB and Simulink

Generate optimized and faster C code invoking ARM® Cortex®-A Ne10 Library.

- Optimized ARM Cortex-A Ne10 library code replacement support for Key DSP algorithms System objects and blocks

- Examples provided in the DSP System Toolbox hardware support package for ARM® Cortex®-A processors

Faster ARM cortex-A optimized C-code generation By 10X factor
Summary

MATLAB/Simulink for Streaming DSP

- DSP System Toolbox provides streaming capabilities for design and simulation of real-time sensor processing in MATLAB and Simulink.
- Once your design works in your desktop, you can deploy it to Low-cost Hardware such as BeagleBone Black, Raspberry Pi, etc.
- With Embedded Coder you can configure your embedded application and implement, test and validate on hardware.
Conclusion

- **IoT and MathWorks Support**
  - MATLAB Mobile
  - ThingSpeak

- **MATLAB for Signal Analytics**
  - Signal Analysis and Filter
  - Machine Learning using Neural Network

- **MATLAB/Simulink for Streaming DSP**
  - Streaming Signal Processing
  - Embedded Code Generation and Verification
Thank You