MATLAB Embedded Coder for Intel Curie Platform

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Agenda

• Intel Atlas Peak Wearable SoC Platform Overview
• Curie Module and Arduino 101
• MATLAB Embedded Coder for Curie Platform
• Case Study – Biking Trick Classifier
• Summary
Atlas Peak SoC Platform Overview

Quark Core (LMT)
- 32 MHz Clock Frequency
- 32-bit Address Bus
- 8 kB L1 Instruction Cache

ARC EM Core - Sensor Subsystem
- 32 MHz Clock Frequency
- I2C Master, SPI Master, ADC, GPIO, timers
- 8 kB L1 Instruction Cache

PVP – Pattern Matching Accelerator
- Parallel data recognition engine
- 128 Neurons with 128 features per Neuron

On-Die Memory
- 384 kB of on-die Flash
- 80 kB of on-die SRAM
Atlas Peak SW Architecture

- Application
  - Application SDK
  - Debug Service
  - BTLE Service
  - USB Service
  - Service Manager

- Device Drivers
  - IPC
  - UART
  - I2C
  - SPI
  - USB
  - mailboxes

- Sensor Subsystem
  - Sensors
  - PVP / Burlington

- OS Services / Zephyr micro

Other Custom Service
- PVP Service
- Sensors Service
- Service Manager Hub
- Service SDK
Curie Module and Arduino 101

**Physical**
- Form Factor: BGA module
- Dimensions: 8x10x2mm (TBD)
- SoC: AtlasPeak 1.0, 32MHz
- Storage: NA
- Memory: within SoC, 80KB RAM
- Sensors: Accel/Gyro,

**Key EE components**
- SoC: AtlasPeak1.0
- Sensor: 6 Axis BMI160
- Charging: BQ25101
- BLE: Nordic nRF51822

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[Diagram showing key components: AtlasPeak SoC, Accel/GYRO BMI160, Charger BQ25100H, BLE Nordic nRF51822, Crys 32k & 16MHz]
Arduino 101

https://www.arduino.cc/en/Main/ArduinoBoard101

Open Source FW Code:

https://github.com/CurieBSP
PVP Pattern Matching Acceleration

- Highly parallel 128-vector distance computation and sorting
- 16KB of closely coupled memory attached to the neurons for high throughput
- Input – vector to be recognized
- Output – fired neurons or the nearest neighbors
- Computationally intensive modules
  - Distance computation between the input vector and reference vector
  - Sorting to find the nearest neighbor, especially for kNN & RBF
MATLAB Embedded Coder for Curie Platform

- Optimization and code configuration options from Mathworks
- Multi-task and multicore code execution
- Best utilize features on Curie platform for quick prototyping
  - x86 Quark CPU
  - ARC DSP with FPU and DSP extension
  - PVP pattern matching HW accelerator
  - Optimized math library for ARC
Case Study – Biking Trick Classifier

- Biking trick: type = {'UnKnown'; 'Big Air'; 'Tobogan'; 'BackFlip'; 'XUp'; 'TailWhip'};
Biking Trick Classifier – Simulink

Generate Code Using Simulink Coder (double-click)  Generate Code Using Embedded Coder (double-click)

Copyright 1994-2012 The MathWorks, Inc.
Biking Trick Classifier – Quark/ARC

```
* Embedded hardware selection: Intel->x86-32 (Windows32)
* Code generation objectives: Unspecified
* Validation result: Not run
*/

#include "demo_model.h"

static Boolean T OverrunFlag = 0;

/* Base rate step function */
void rt_OneStep()
{
  /* Check for overrun */
  if (!OverrunFlag++) {
    rtSetErrorStatus(demo_model_N, "Overrun");
    return;
  }
  /* Step the model for base rate */
  demo_model_step();
  /* Get model outputs here */
  OverrunFlag--;
  /* Disable interrupts here */
  /* Restore FPU context here (if necessary) */
  /* Enable interrupts here */
}

/* Genesis target Main function */
void mw_arc_initialize(void)
{
  /* Initialize model */
  demo_model_initialize();
}

/* Genesis target Main function */
void mw_arc_terminate(void)
{
  /* Terminate model */
  demo_model_terminate();
}
```
Biking Trick Classifier - PVP

- DRIVER_API_RC qrk_cxxxx_pvp_recognize_vector(…)
- DRIVER_API_RC qrk_cxxxx_pvp_save_knowledge(…)
- DRIVER_API_RC qrk_cxxxx_pvp_load_knowledge(…)
- DRIVER_API_RC qrk_cxxxx_pvp_set_config(…)
- DRIVER_API_RC qrk_cxxxx_pvp_get_config(…)
- DRIVER_API_RC qrk_cxxxx_pvp_reset_database(…)
- DRIVER_API_RC qrk_cxxxx_pvp_read_neuron(…)
- DRIVER_API_RC qrk_cxxxx_pvp_clock_enable(…)
- DRIVER_API_RC qrk_cxxxx_pvp_clock_disable(…)

Movement Detection
Pre-Processing (LPF, normalization etc.)

L1 Distance Computation
Sorting (KNN, RBF)

Knowledge Base (Training Model)

Output Biking Trick Recognition Result
Demo Session

• Run Biking Trick Classifier purely in MATLAB Simulink.
• Embedded Coder generates the ARC optimized C code, and then uses Curie platform toolchain to compile and generate the library.
• Library is further built with CurieBSP firmware codebase and becomes part of firmware image.
• Flash the newly generated image to Arduino 101, and the same result is shown.
Summary

- Intel Atlas Peak SoC brings extremely low power and rich feature set for wearable and IOT segments.
- MATLAB Embedded Coder supporting for Atlas Peak platform enables broader eco-system adoption for quick prototyping, code and algorithm optimization.