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

OS Services / Zephyr micro

Lakemont

UART
I2C
SPI
USB

mailboxes

Other Custom Service

Service Manager Hub
PVP Service
Sensors Service

IPC
Device Drivers

OS Services / Zephyr nano

Sensor Subsystem

Sensors
PVP / Burlington

PVP Service
Sensors Service
Curie Module and Arduino 101

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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

```c
#include "demo_model.h"

static Boolean T OverageFlag = 0;

/* Base rate step function */
void rt_OneStep()
{
    /* Check for overun */
    if (!OvertimeFlag++)
    {
        rtsSetErrorStatus(demo_model M, "Overture");
        return;
    }

    /* Step the model for base rate */
    demo_model step();

    /* Get model outputs here */
    OvertimeFlag--;

    /* Disable interrupts here */
    /* Restore CPU 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.) -> Feature Extraction

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.