Real-Time Systems

Overview of Single Board Computers Used for Education

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Embedded Systems Engineering Program

R-Pi 3b+ (R-Pi 4) – Used in this Course and Series

Embedded Development and test with Raspberry Pi 3 model B+ from CanaKit described on eLinux

Raspbian Linux:

1. R-Pi 3b+
2. R-Pi 4
3. **Low cost, widely available, simple to learn**

Support by eCos:

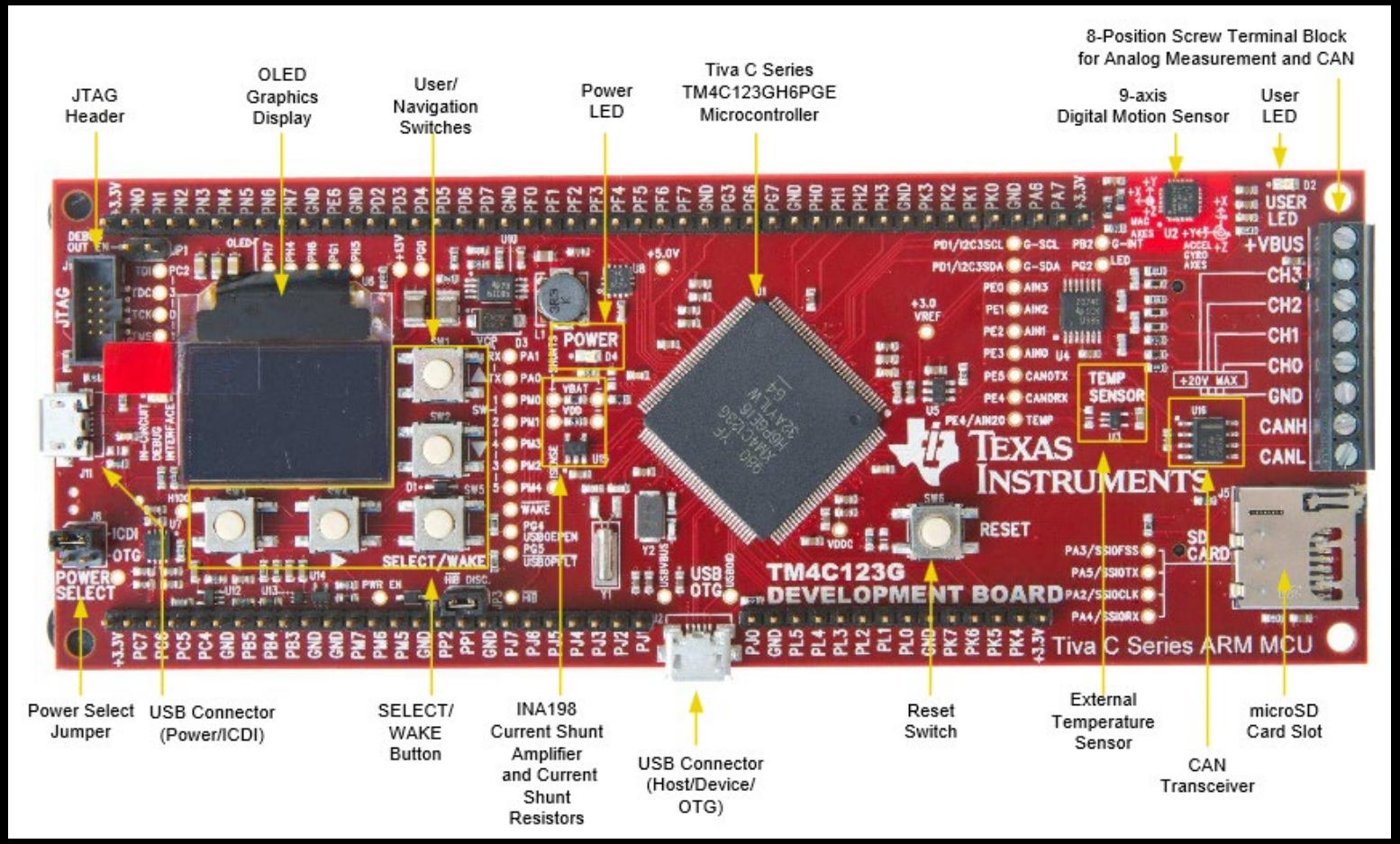
1. https://www.ecoscentric.com/rpi/,
2. **Cross development and patches for better real-time performance**

RTES R-Pi 3b+ Setup

- USB2 C270 camera
- Mouse, keyboard
- HDMI monitor
- Running RT Canny Transform

Scale-Down MCUs – Texas Instruments (TIVA)

ARM Cortex M4 Microprocessor, IAR or Code Composer IDE, Cyclic Executive or FreeRTOS



ARM M-Series SBC:

1. TIVA TM4C123G DEV BOARD,
2. TM4C123G MCU,
3. ARM Cortex,
4. TM4C123GXL Launch Pad

ARM M-Series IoT Boards:

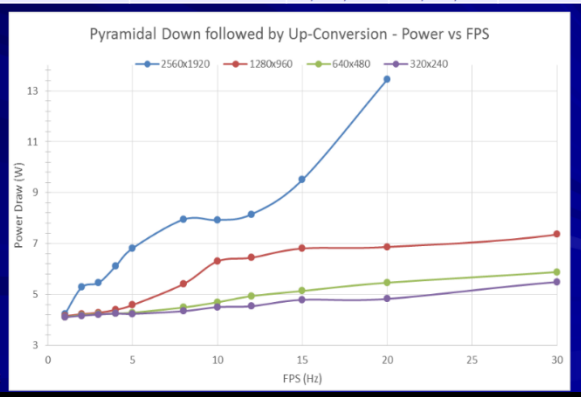
1. IoT Enabled TM4C129X Connected Development Kit ,
2. TM4C1294XL Connected Launch Pad

Scale-Up Embedded GP-GPU SoCs - Jetson

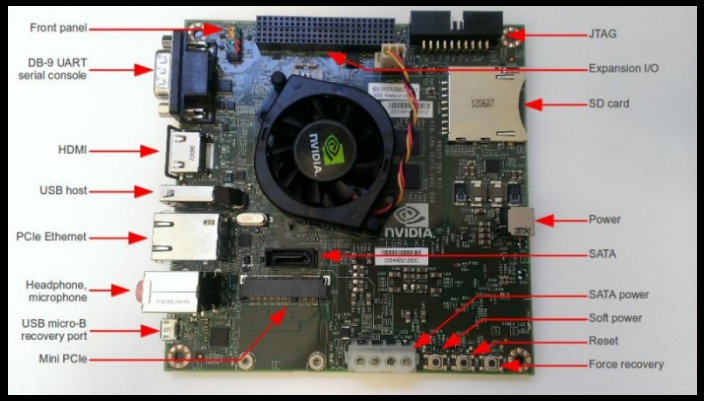
- Older Jetson TK1 CPU+GPU
  - NVIDIA "4-Plus-1" 2.32GHz ARM quad-core Cortex-A15
  - NVIDIA Kepler "GK20a" GPU with 192 SM3.2 CUDA cores (up to 326 GFLOPS)
- Newer Jetson Nano Tegra K1
  - Competitive with R-Pi, TI OMAP, etc. in terms of price, no fan, etc.
  - Same Tegra K1 SoC
  - Much more compact
  - Good for student projects involving machine vision, AI

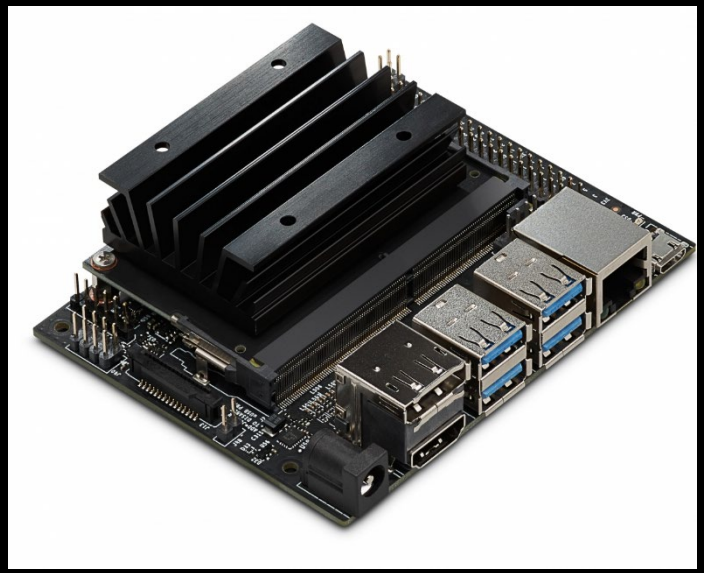
Table 6. Pyramidal Up and Down Conversion Continuous Transform Power

Resolution	Continuous Power at 1Hz (Watts)	Continuous Power at 20Hz (Watts)	(pixels/sec) / Watt @ 1Hz	(pixels/sec) / Watt @ 20Hz	Saturation FPS
320x240	4.104	4.824	18,713	477,612	1120
640x480	4.116	5.460	74,636	1,687,912	325
1280x960	4.152	6.864	295,954	5,370,629	82
2560x1920	4.224	13.44	1,163,636	10,971,429	20



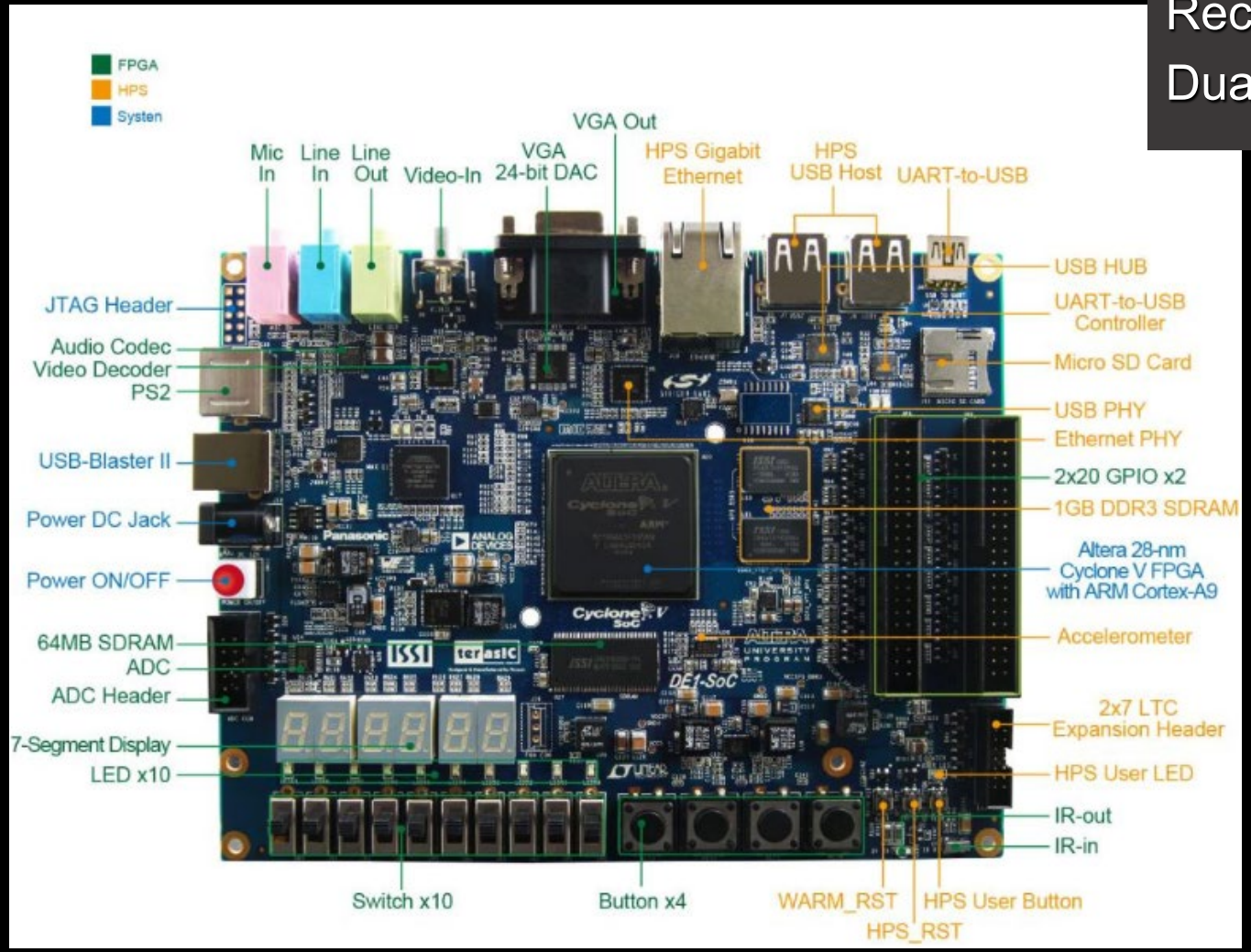
Siewert, Sam, et al. "Software defined multi-spectral imaging for Arctic sensor networks." *Algorithms and Technologies for Multispectral, Hyperspectral, and Ultraspectral Imagery XXII*. Vol. 9840. International Society for Optics and Photonics, 2016.





Hybrid FPGA SoC Devices – DE1-SoC

Reconfigurable SoC with FPGA Co-processing Dual-Core ARM Cortex A9, Linux or FreeRTOS



- ALUTs: 24456
- Registers: 34,062
- Logic utilization: 17,721 / 32,070 (55 %) (55 %)

Table 3. Pyramidal Laplacian Resolution Up-Conversion Continuous Transform Power

Resolution	Transform (Watts)	(Pixel/sec) per Watt	Saturation FPS	Bus transfer rate (MB/sec)
320x240	6.009	889,546	69.6	5.10
640x480	6.013	904,281	17.7	5.19
1280x960	6.038	905,624	4.45	5.21
2560x1920	6.192	889,054	1.12	5.25

Table 4. Pyramidal Gaussian Resolution Down-Conversion Continuous Transform Power

Resolution	Continuous Transform Power (Watts)	(Pixel/sec) / Watt	Saturation FPS	Bus transfer rate (MB/sec)
320x240	5.968	2,445,040	190	13.92
640x480	6.018	2,399,202	47.0	13.77
1280x960	6.023	2,427,813	11.9	13.95
2560x1920	6.109	2,309,154	2.87	13.45

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