

Multi-camera system with integrated NVIDIA Tegra X1 SoM
for embedded vision applications



- Drones and UAV
- Autonomous Robotic Systems
- Industrial Embedded Imaging
- 3D Vision

NVIDIA Corporation and consortium of NVIDIA community members offer compact comprehensive solution based on the NVIDIA Jetson Tegra X1 supercomputer module for multi-camera embedded, 3D Vision, airborne and other mobile applications.

Key features of the platform

- Revolutionary NVIDIA Maxwell™ architecture
- Extremely diversified and highly modular XIMEA camera family xiC / xiX
- CUDA® parallel computing platform and programming model invented by NVIDIA
- Outstanding Fastvideo SDK for high-performance imaging on NVIDIA GPUs
- MRTech Image Flow software for building full image processing pipelines

Components of the platform

Complete set for UAV, embedded system etc

1. NVIDIA Jetson TX1
2. Up to four XIMEA xiC / xiX cameras
3. xiLab Phoxi carrier board
4. MRTech IFF software including Fastvideo SDK

NVIDIA Jetson Tegra X1 supercomputer module

Jetson TX1 is a supercomputer on a module that's the size of a credit card. It features the new NVIDIA Maxwell™ architecture, 256 NVIDIA CUDA® cores, 64-bit CPUs, and unmatched power efficiency.

See more at: <http://www.nvidia.com/object/embedded-systems.html>

XIMEA xiC / xiX cameras for embedded and OEM applications

The xiC is highly modular camera family designed for the Sony Pregius™ image sensor series. It offers multiple choices of combining image sensors and interfaces such as USB 3.1 and PCIe. The small xiX cameras are based on the same board-level concept and stream images to the host computer via 2 lanes on a PCI Express Gen2 bus. Thanks to flat flex cabling, the board-level and semi-housed variants allow integration in tight spaces and proximity between cameras.

See more at <https://www.ximea.com/en/products/oem-custom-cameras>



Pic.1 Photoneo PhoXi 3D scanner

Phoxi carrier for NVIDIA Tegra X1 SoM and XIMEA embedded cameras

Specialized carrier for NVIDIA® Jetson TX1 module was specially designed by XIMEA xiLab for customized USB3 and PCIe board-level cameras in 3D Vision industrial applications. Hardware configuration of the system is determined by the needs of the customer and is built around NVIDIA Jetson TX1 System-on-Module's capabilities including:

- 10/100/1000 Ethernet
- WiFi - IEEE 802.11ac with maximum transfer rate 800 Mbps
- Bluetooth 4.0 with maximum transfer rate 24 Mbps
- Two USB 3.0 port for FFC / FPC cable
- Two PCIe Gen2 x2 ports for FFC / FPC cable
- General-purpose inputs / outputs (GPIO)



Pic.2 Jetson TX1 SoM and Phoxi carrier

Fastvideo SDK for high performance Image & Video Processing on GPU

As the platform has NVIDIA GPU, that's strongly recommended to use high-performance CUDA Image & Video Processing SDK from Fastvideo for image and video processing on GPU. That SDK is a set of separate components which correspond to standard image processing pipeline for camera applications: demosaicing, denoising, resizing, sharpening, color correction, 1D and 3D LUTs, JPEG and JPEG2000 compression, etc.

See more at <http://www.fastcompression.com/products/sdk/sdk.htm>

MRTech universal Image Flow Framework

Image Flow Framework is a cross-platform software for building full image processing pipelines in machine vision systems. MRTech company offers the service to implement and customize integrated software solutions for the represented platform. Framework has all basic functions for image processing, includes Fastvideo SDK for CUDA Image & Video Processing and potentially allows to add any filters, libraries, or primitives which are needed for a particular machine vision system.

See more at <https://mr-technologies.com/image-flow-framework/>

Review of the platform's performance

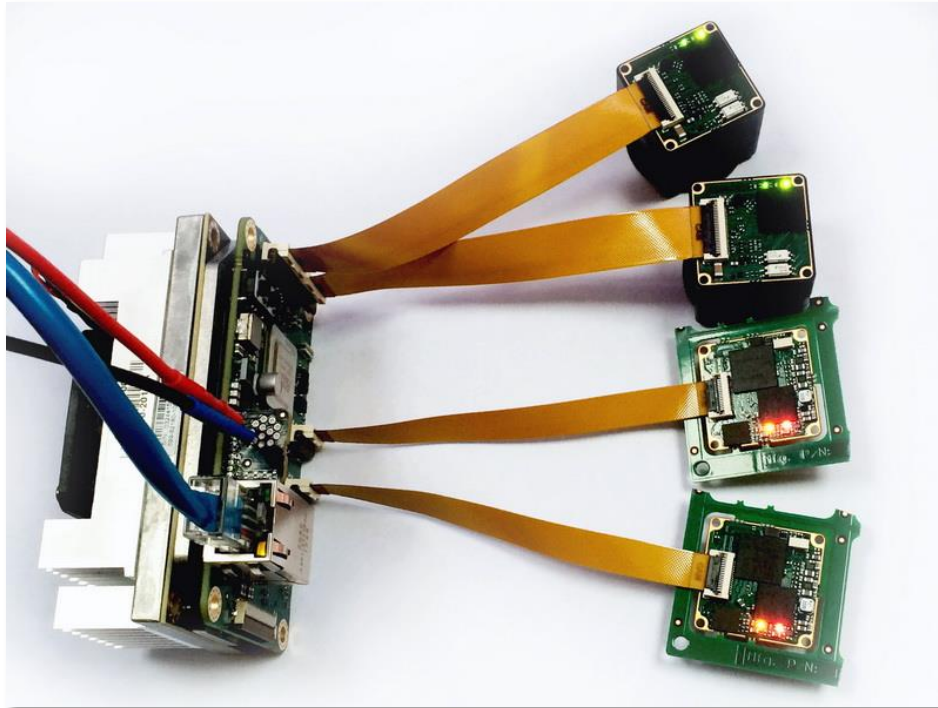
Test benchmark 1 – hardware

Hardware setup includes:

- Two 4.2 MPix cameras connected via USB 3.0 ports
- Two 12.4 MPix cameras connected PCIe Gen x2 ports

Hardware allows to get in the RAM of Tegra X1 SoM simultaneously:

- 2 x 49 FPS from 4.2 MPix USB3 cameras with maximum bandwidth 425 MB/s
- 2 x 66 FPS from 12.4 MPix PCIe cameras with maximum bandwidth 1640 MB/s



Pic.3 Setup for hardware tests

Test benchmark 2 – Image processing

Setup includes 2 cameras with the same 8.9 MPix sensor from Sony:

- MC089CG-SY-FV - USB3 interface
- MX089CG-SY-X2G2 - PCIe Gen2 x2 interface

Processing pipeline consists of the following steps:

1. Black level subtraction
2. White balance
3. Demosaicing
4. Conversion from RGB to RGBA format
5. Render on the screen

All steps are done on GPU using CUDA and OpenGL (for rendering) technologies. Step 4 isn't optimized at the moment and accounts for ~20% of processing time.

Two benchmarks were run with both cameras acquiring simultaneously:

1. Full frame - 20 frames per second with full pipeline latency 35 ms
2. FullHD ROI - 75 frames per second with full pipeline latency 28 ms

If run with only one camera FPS count doubles. GPU load reaches 100% during these tests.

Due to absence of monitor output port VNC protocol is used for demonstration purposes, but SSH can be used for testing instead.

Partnership

NVIDIA Corporation - www.nvidia.com

- Supplier of Jetson TX1 Supercomputer on a Module and provider of Parallel computing platform CUDA®



XIMEA - www.ximea.com

- Manufacturer of innovative industrial cameras and Tegra X1 SoM specialized carrier designed by XIMEA xiLab



Fastvideo - www.fastcompression.com

- Developer of CUDA-based Image & Video Processing SDK for NVIDIA GPUs



MRTech SK - www.mr-technologies.com/

- Manufacturer of cross-platform Image Flow Framework for image processing and overall solution's provider worldwide



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