Inuitive Breakthrough Solution for AR and VR Worlds

Dor Zepeniuk, VP R&D
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Inuitive Background

- A fabless semiconductor startup company established 4.5 years ago with a mission to develop industry leading, cutting edge 3D Imaging and Vision Processors

- Located in the heart of the Israeli high tech industry there we are part of an emerging AR/VR technological ecosystem

- We are a team 80 R&D professionals – bringing ~1000 accumulated years of experience in the fields of Imaging, Computer Vision, Optics, Embedded Systems and System on Chip design

- We are developing both the System-on-Chip and the system around it

- Our first product, the NU3000, is already in production & well accepted as the smart sensor hub of choice by leading AR/VR HMDs developers

- Our next-gen product, the NU4000, is a revolutionary processor solution for any device that need to develop perception of the scene around it
Our SoC Roadmap

NU3000
Multi core CV and depth processor
Dedicated depth engine
40nm geometry
Connects to 3 cameras
12X10mm

NU4000
Improved depth and vision performance
Lower power, 28nm geometry
3D imaging accelerator Smart sensor hub
Deep Learning Processor
Connect to 6 cameras and a display
6.7x6.4mm

NU4100 - tentative
Depth processor
Tango Tracking Algorithms
Connect to 4 cameras
4.0x4.0mm

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The Challenges

• Advanced implementations of VR/AR HMDs, Robots and Drones consists of many image sensors - can reach 6, 8 or more

• Many sensors → heavy image processing & computer vision requirements

• Heavy computing → memory becomes a bottle neck

• Advanced use cases (gaming, navigation) → low latency is critical

• Mobile use cases → power efficiency is extremely important

• Consumer electronics → mass-market penetration is gated by cost

Inuitive's NU4000 is designed to address those challenges and more
Inuitive Architectural Concept

• Market requirements justifies an optimized depth and vision processor which will combine between depth sensing accelerators, computer vision accelerators and computer vision processor(s)

• Inuitive approach is to adopt the most suitable processing technology/module for the different processing tasks:
  • NU4000 is integrating several types of processing engines to address different tasks of market’s diverse use cases
  • Combining between highly optimized hardwire HW engines and fully SW programmable cores → best power/performance tradeoff
  • Use processing pipelines with dedicated SRAM → reduce DDR load
  • Offer ideal tradeoff between performance, scalability, flexibility, power consumption and cost
  • Best-of-breed architectural approach!!!
NU4000 Architecture
Best In Class 3D Imaging & Vision Processor

**NU4000**

- **Peripherals and Interfaces**
- **Image Acquisition Engine**
- **Post Processing Engine**
- **Depth Processing Engine**
- **Deep Learning Processor**
- **Computer Vision Accelerators**
- **Vision Processor**

**Features**

- LPDDR2, LPDDR3, USB2.0/3.0
- 4xUART, 2xSPI, 6x2C, I2S, 48xGPIO, 6xTimers, 2xWDT
- Global Timing Unit
- Image Scalers
- ROI Cropping blocks
- Histograms
- Data Packing
- Disparity to Depth
- RGB-Depth Registration
- Fully programmable Convolutional Neural Networks Engine.
- Process >100 AlexNet ROIs per seconds.
- Reduce DDR bandwidth
- ARM Cortex-A5 + FPU & Neon co-processor
- Running at 1GHz with Embedded Linux OS
- 6 x MIPI-Rx Ports
- 3 x MIPI-Tx Ports
- Stereo Pre-Processing – Distortion Rectification (120x90Deg), Images alignment and balance
- State of the Art Depth from Stereo Engine, 3rd generation design
- 120Mp/s - FHD@60fps, 720p@120fps Below 1msec latency
- Very low power & zero Latency Vision Modules
- DoG, HoG, FAST, ORB, FREAK & Normal Estimation – HD@60fps or 2xVGA@60fps
- Ceva XM4
- Most advanced Vision Processor in the market running at 800MHz
VR/AR System Based on NU4000

Digital Camera:  
- IMU
- Gaze Tracking Pair – OVM 6211
- Vis Tracking pair – OV7251
- IR Depth-Stereo pair - OV9282

Media Support:  
- Display L
- Display R

Application Processor

Networks:  
- MIPI-Tx
- MIPI-Tx or USB3.0
Example 1: Optimized CNN Solution by HW/SW

**NU4000**

- Peripherals and Interfaces
- Image Acquisition Engine
- Post Processing Engine
- Depth Processing Engine
- Computer Vision Accelerators
- Deep Learning Processor
- Vision Processor
- RISC Processor

**Pre-Processing Functions:**
- Scaling, resizing
- Pyramids
- Background reduction
- ROI Selection
- Depth based Segmentation

**CNN Functions:**
- CNN Graph processing
- Convolution Acceleration
- Object detection & recognition

**Optimized tradeoff between flexibility and performance**
Example 2: SLAM Optimization by HW/SW

Optimized tradeoff between flexibility and performance

Features Detection Functions:
- Scaling, resizing
- Pyramids
- Histograms
- Feature extraction

Features Tracking & Mapping:
- Features matching
- Frame to Frame tracking
- 3D scene reconstruction
Inuitive Offering Advantages (1)

• Optimized solution for mobile devices - Low power, Small form factor
• Operates both indoor and outdoor
• Provide seamless coexistence of multiple users for both passive and active solutions
• Highly scalable and flexible solution – same chip suitable for multiple platforms and variety of use-cases by using off-the-shelf optical components
• Inuitive provides to its customer both powerful 3D Imaging & vision processor as well as system solution for depth sensing (optics, calibrations, reference design)
Inuitive Offering Advantages (2)

• Effective architecture for diverse applications – Mobile, AR/VR, Robotics, Drones, Scanning

• Unique architecture that addresses the challenges of VR/AR HMDs
  • The only solution to Combine depth sensing with computer vision
  • Best in class Vision Processor combined with Vision Accelerators:
    • Ultimate power efficiency
    • Best vision-performance/power & performance/$ ratios
  • Integrate all timing-critical sensing functions to one device/entity
Thank You!
Reference Design Modules

M3.1T
Released: Q3 2015
Applications: surveillance, elderly care tracking

M3.2 Line
Released: Q1 2016
Applications: Mobile, Google Tango
3 versions:
• 60mm baseline with color camera
• 60mm baseline with Fisheye camera
• 25mm baseline smartphone version (Twiggy)

VR/AR Reference Platform – Veronica
Early Adaptors Release: Q3 2016
Wide FoV, VR Middleware
Applications: VR, AR

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