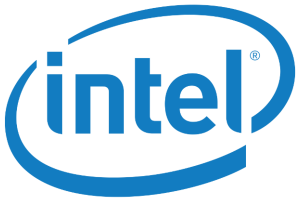


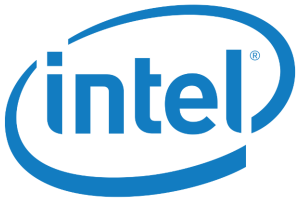
Embedded System Design

Peripheral Devices for Embedded Systems

Rafał Kapela

June 26, 2016

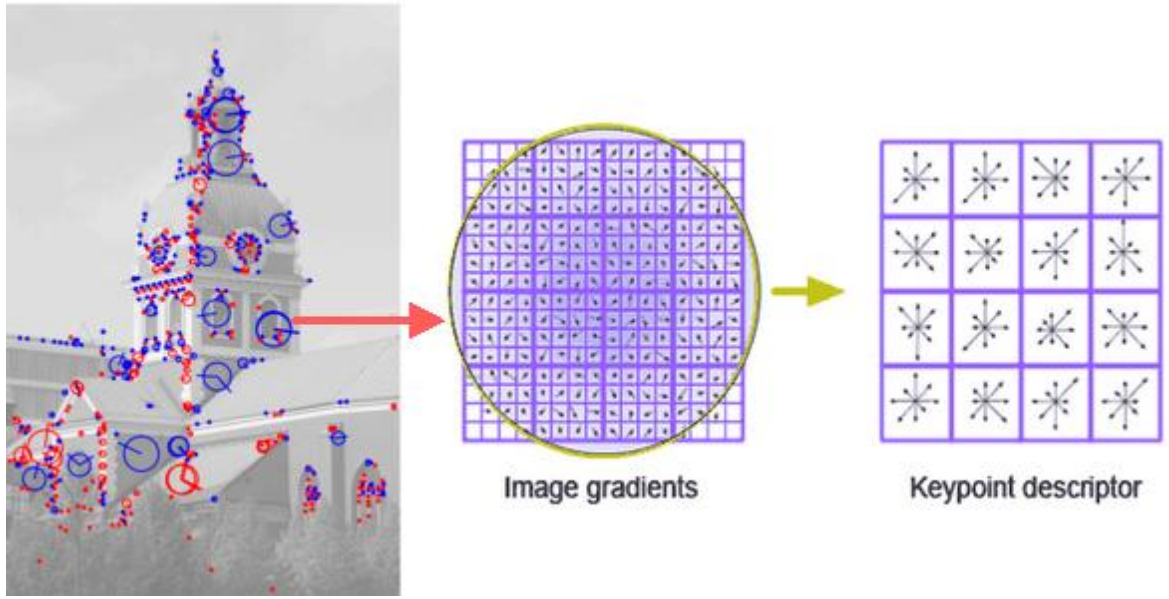
Outline



Introduction

Image processing challenges

Local detection/description



Introduction

Image processing challenges

Stereo correspondence

(a) (b)

(c)

Introduction

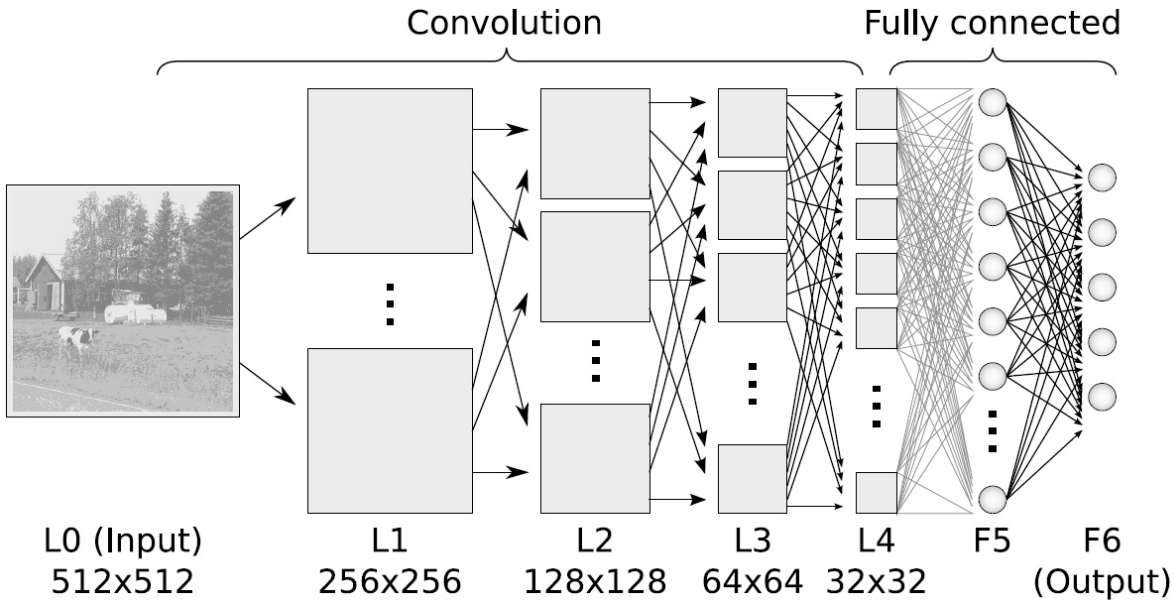
Image processing challenges

Video decoding/encoding

Introduction

Image processing challenges

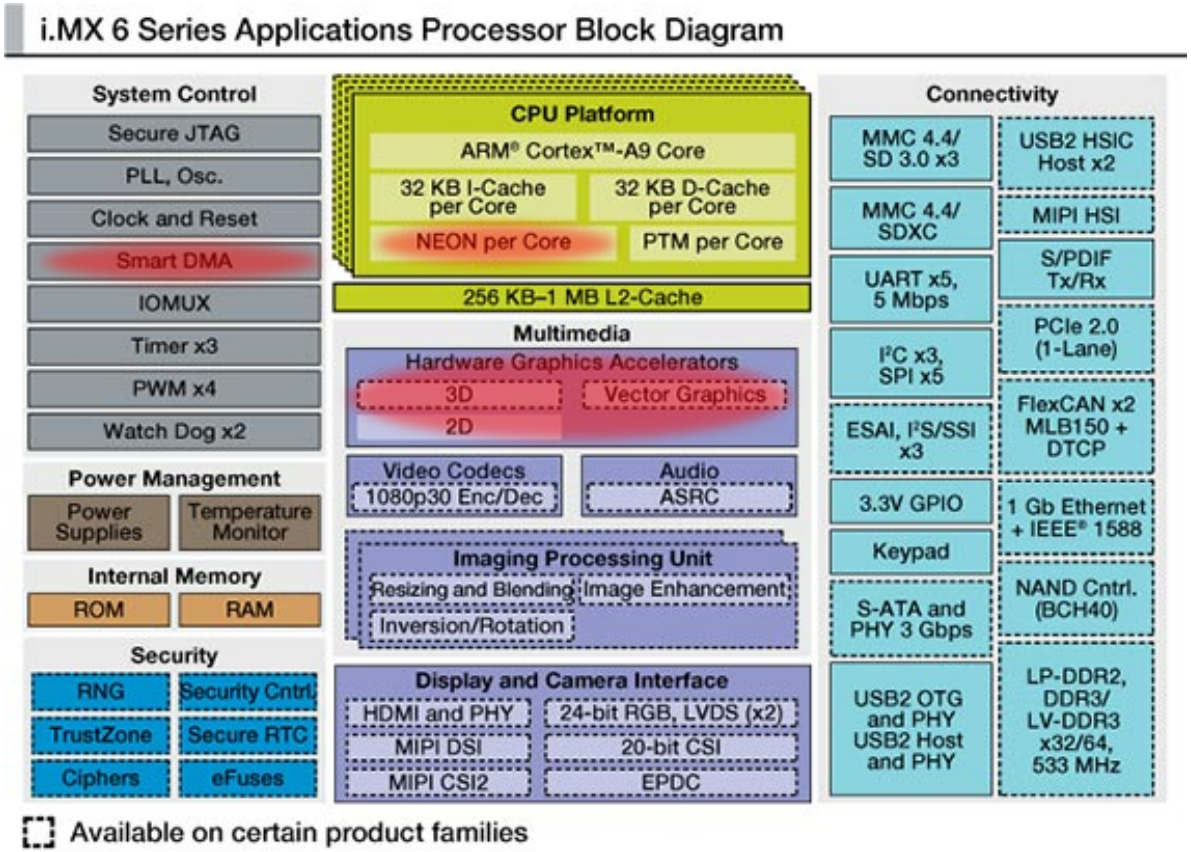
Deep learning



Introduction

Available technologies

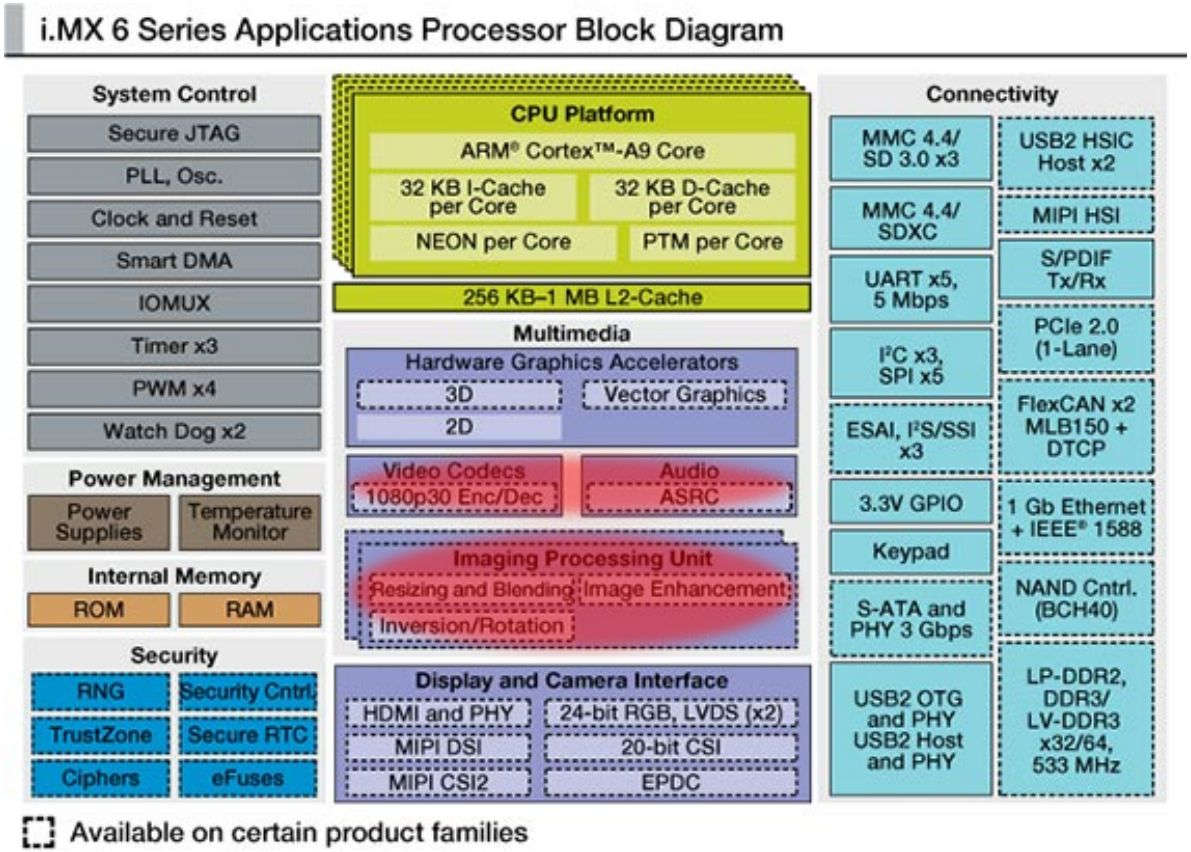
Embedded processor extensions/utilities



Introduction

Available technologies

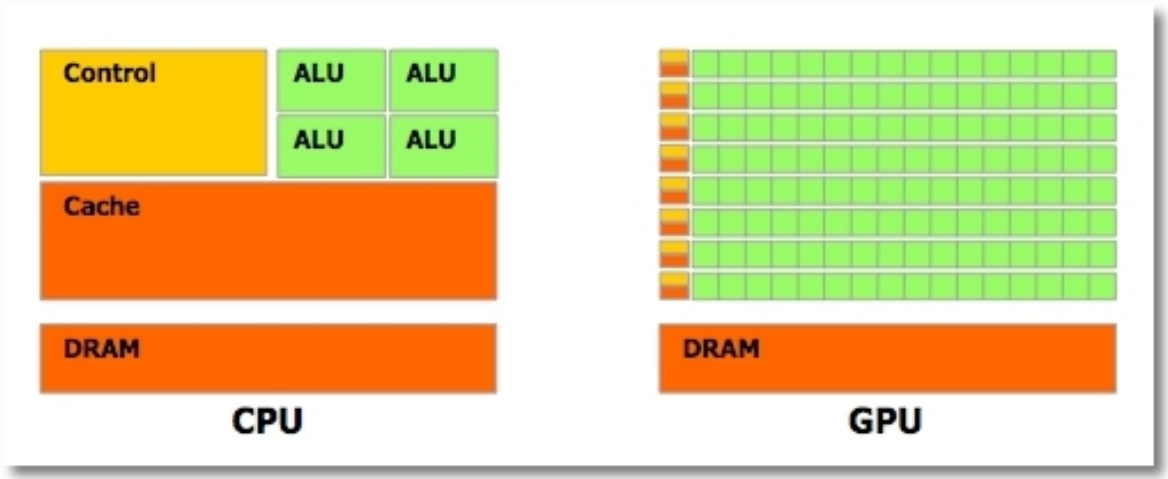
Hardware acceleration units (SoC)



Introduction

Available technologies

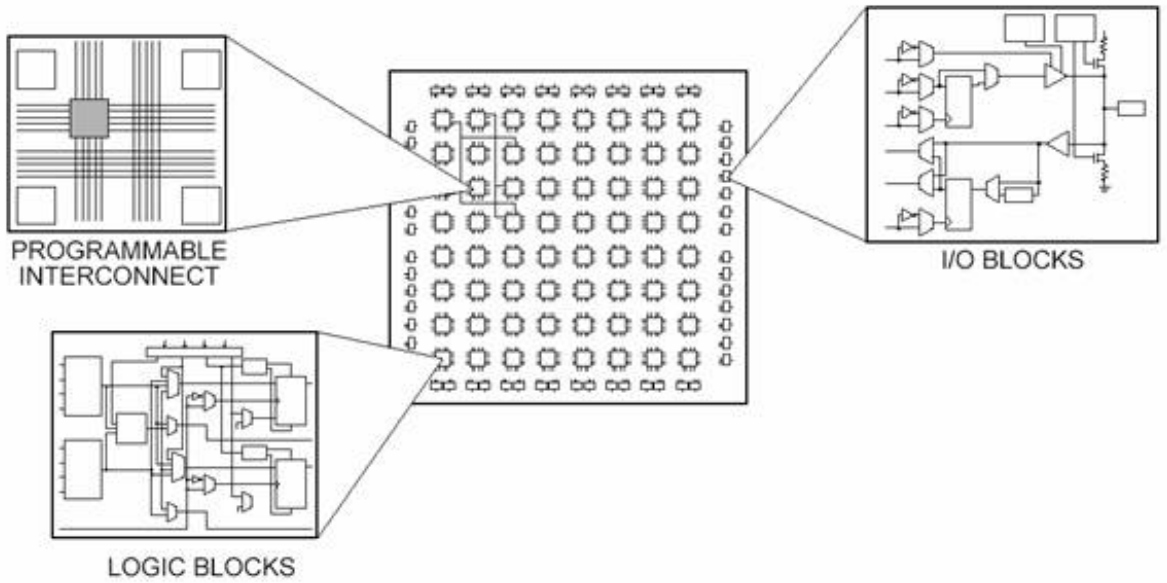
CUDA



Introduction

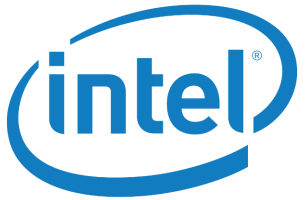
Available technologies

FPGA



Local detection/description

FREAK on zynq



Fast REtinA Keypoint

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Local detection/description

FREAK on zynq

Fast REtinA Keypoint

- extracts information using DoGs (Differences of Gaussians)
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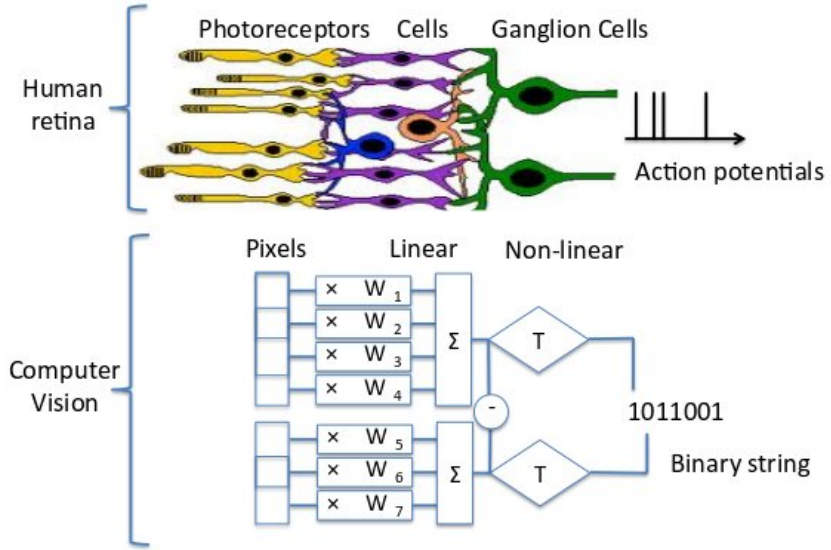
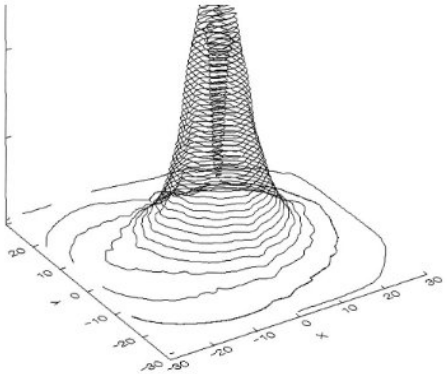


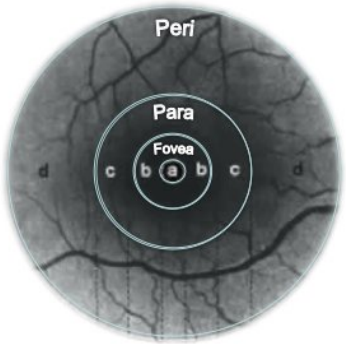
Local detection/description

FREAK on zynq

Fast REtinA Keypoint

- extracts information using DoGs (Differences of Gaussians)
- the spatial distribution of ganglion cells reduces expotentially with the radial distance from the foveola
-



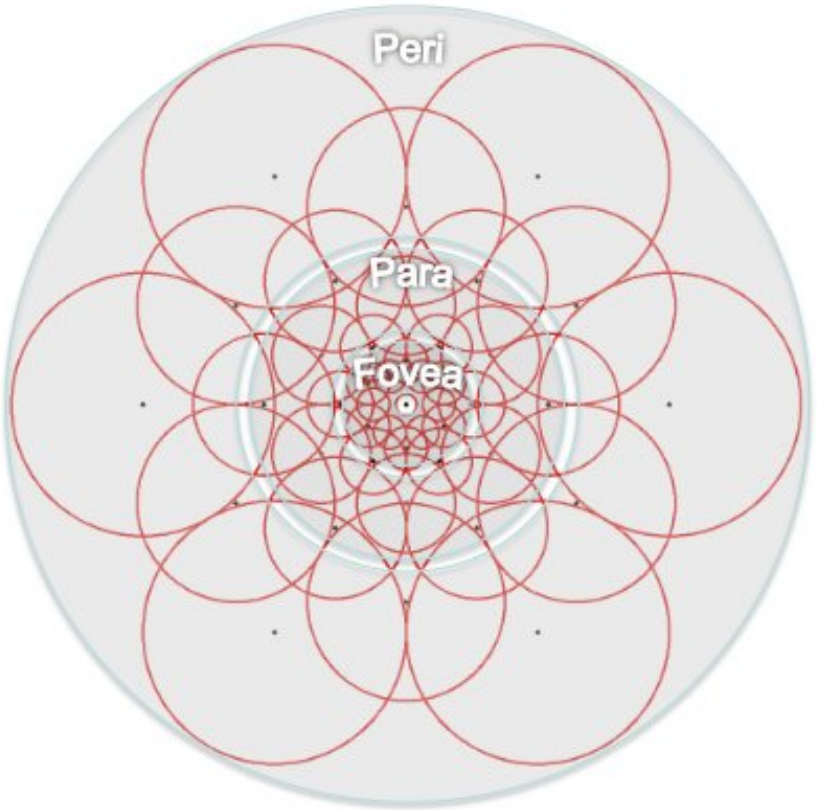


Local detection/description

FREAK on zynq

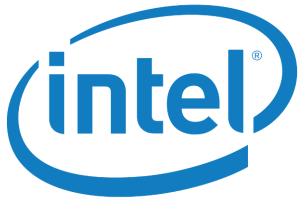
Fast REtinA Keypoint

- extracts information using DoGs (Differences of Gaussians)
- the spatial distribution of ganglion cells reduces expotentially with the radial distance from the foveola
- the size of the receptive field increases with radial distance from the foveola



Local detection/description

FREAK on zynq



Fast REtinA Keypoint - zynq implementation

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1

[1] Rafal Kapela, Karol Gugala, Pawel Sniatala, Aleksandra Swietlicka, Krzysztof Kolanowski, Embedded Platform for Local Image Descriptor Based Object Detection, Journal of Applied Mathematics and Computation

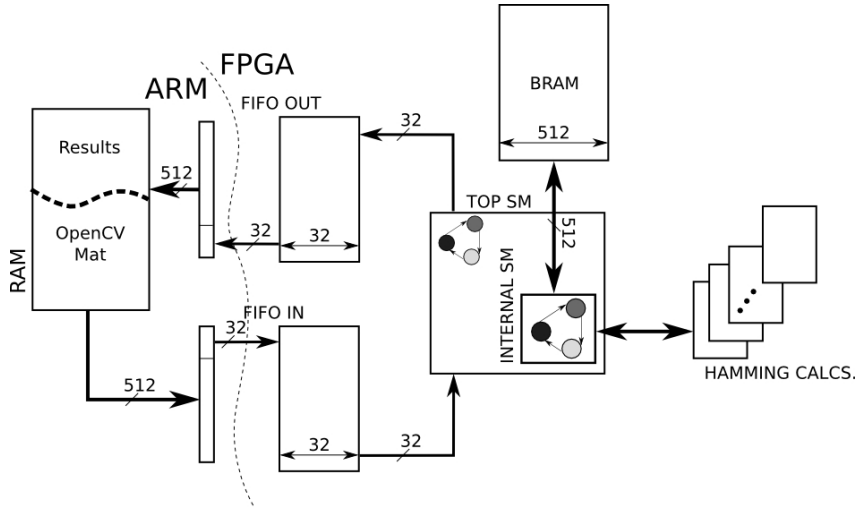
Local detection/description

FREAK on zynq

Fast REtinA Keypoint - zynq implementation

- keypoint detection and description done in software
-
-

1



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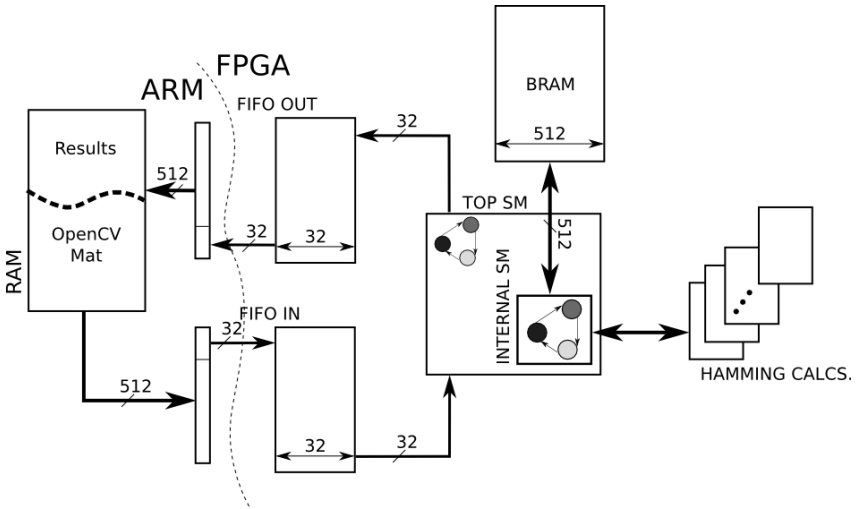
Local detection/description

FREAK on zynq

Fast REtinA Keypoint - zynq implementation

- keypoint detection and description done in software
- hardware acceleration done for descriptor matcher
-



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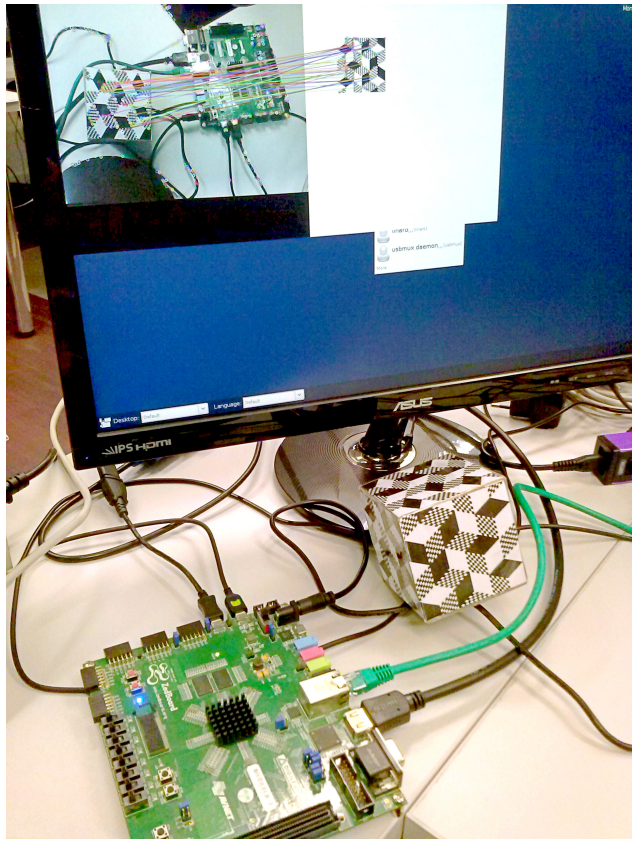
Local detection/description

FREAK on zynq

Fast REtinA Keypoint - zynq implementation

- keypoint detection and description done in software
- hardware acceleration done for descriptor matcher
- Linux device driver that binds two parts together

1



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Local detection/description

VISION – Field Sports Event Detection

Video content detection in real-time

2 3

[2] Rafal Kapela, Kevin McGuinness, Noel Edward O'Connor, Real-time field sports classification using colour anf frequency space decompositions, Journal of Real-time Image Processing

[3] Rafal Kapela, Aleksandra Swietlicka, Noel E. O'Connor, Andrzej Rybarczyk, Krzysztof Kolanowski, Real-time Event Classification in Field Sports Videos, Signal Processing: Image Communication

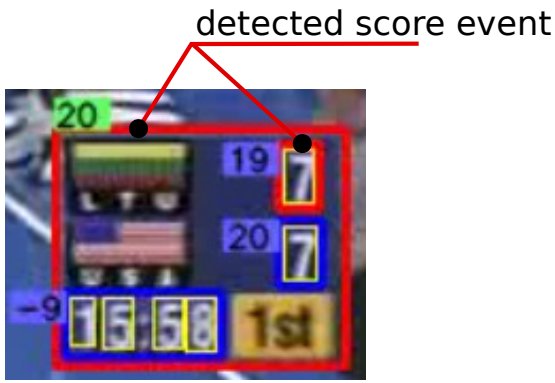
Local detection/description

VISION – Field Sports Event Detection

Video content detection in real-time

- real-time scoreboard analyzer
-
-

2 3



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Local detection/description

VISION – Field Sports Event Detection

Video content detection in real-time

- real-time scoreboard analyzer
- real-time multithread camera-view detector
-

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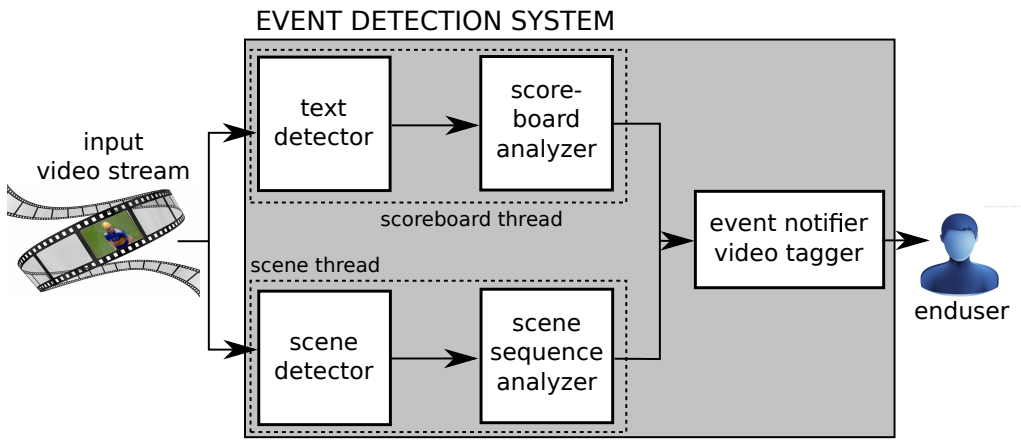

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Local detection/description

VISION – Field Sports Event Detection

Video content detection in real-time

- real-time scoreboard analyzer
- real-time multithread camera-view detector
- real-time cascade classifier

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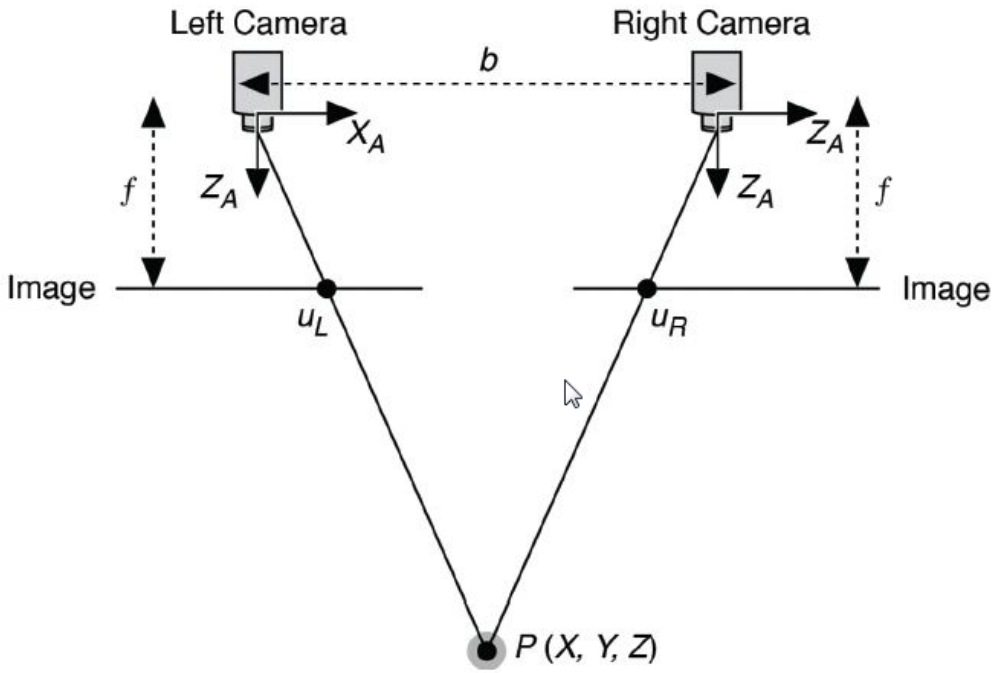
Stereo correspondence

gimme2 board

RT stereo-vision=**55MOPS** (QVGA) – 6.7fps on PC CPU



4

[4] High-speed FPGA-based stereovision system - a success story, Rafal Kapela, Karol Gugala, Antmicro Ltd/Poznan University of Technology, FPGA World Conference

Stereo correspondence

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- custom embedded stereo-vision platform
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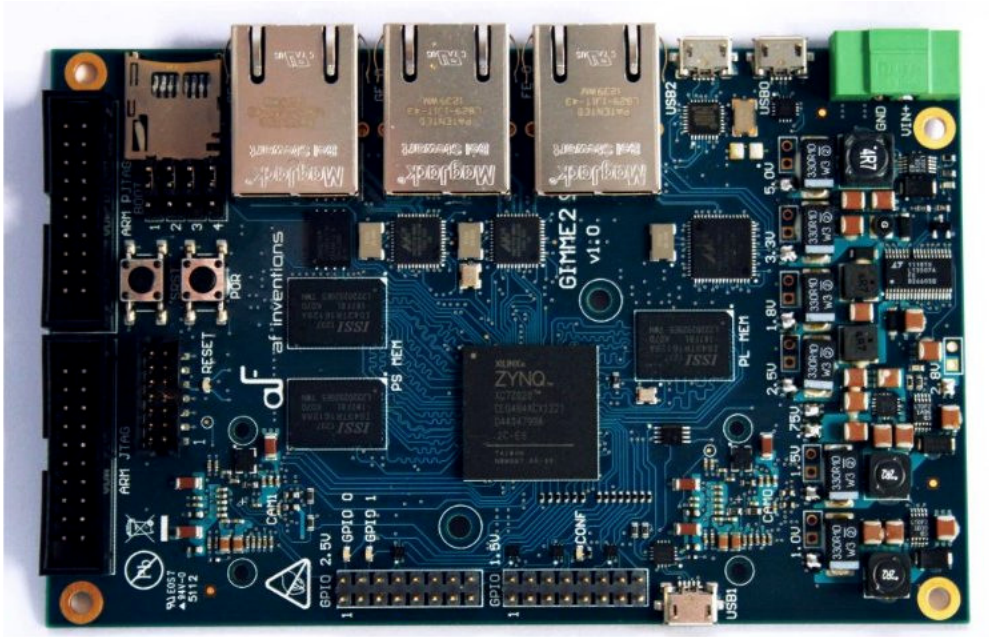

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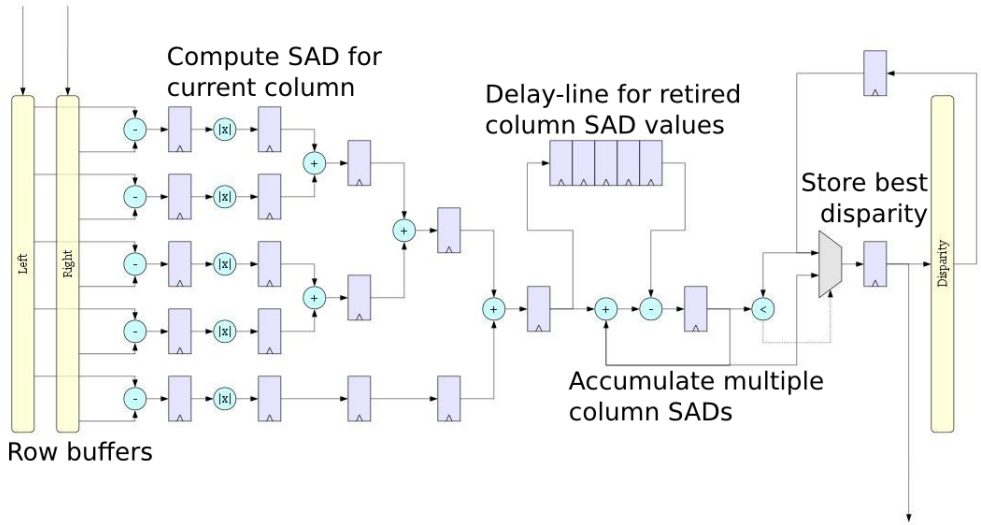
- custom stereo-vision IPcore



4

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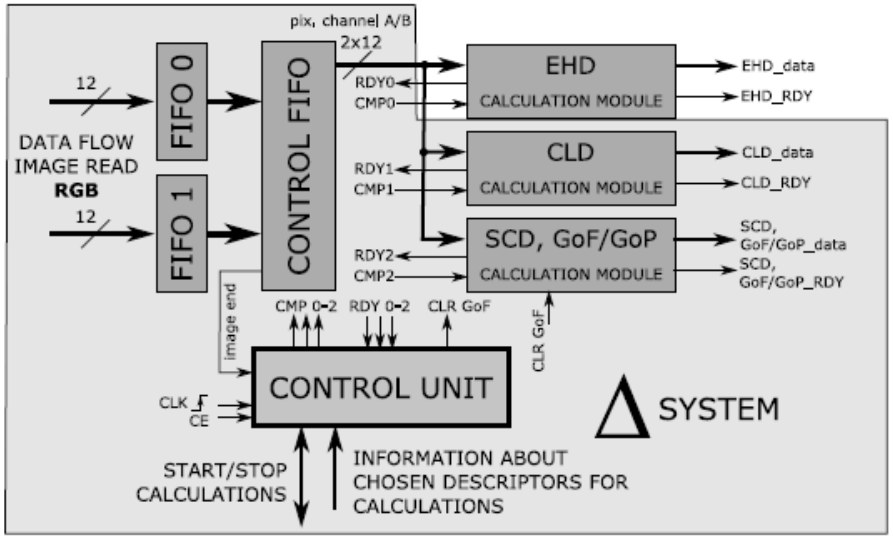
Other algorithms

Object detection

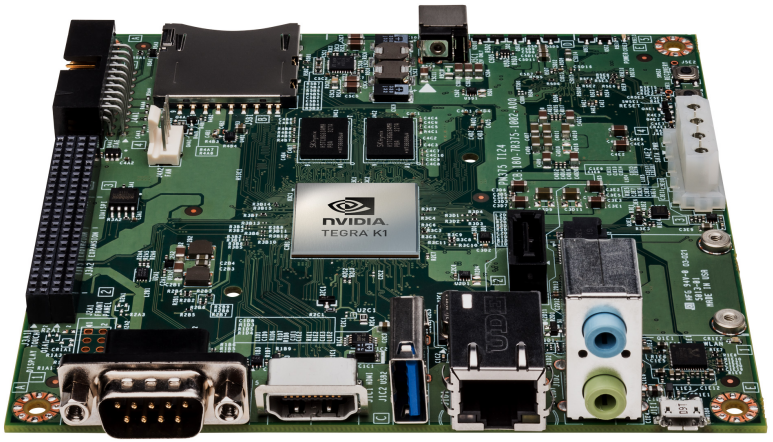
MPEG-7 real-time content description system



Other algorithms

Object detection

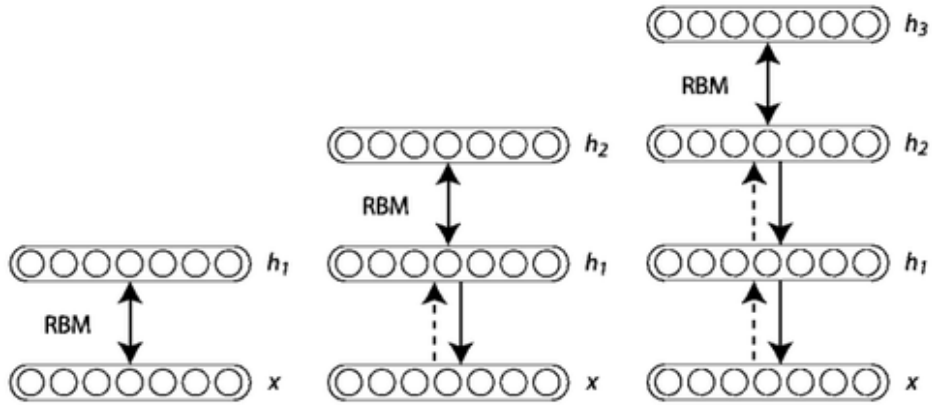
Histograms of Oriented Gradients with CUDA on Jetson TK1



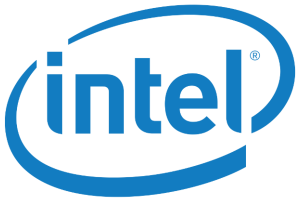
Other algorithms

Object detection

Deep Believe Networks & Restricted Boltzman Machines with CUDA



Conclusions



- Embedded computer vision is usually perceived as limited implementation of high demanding PC algorithms.
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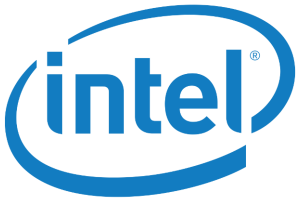
Conclusions



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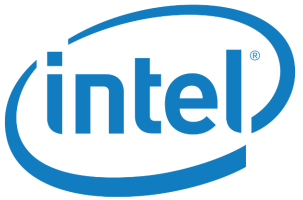
Conclusions



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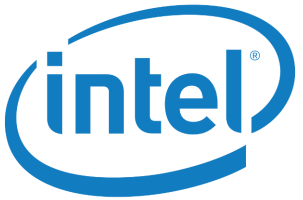
Conclusions



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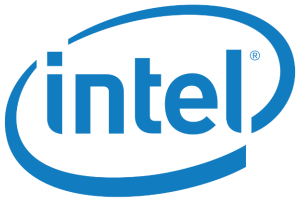
Conclusions



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- In the coming years, embedded vision will change the world by rapidly proliferate into many life areas, creating opportunities for industry and academia.
- But implementing embedded vision applications is challenging, and there is limited know-how.
- Golden rule in embedded computer vision: be realistic - its always system level problem.