Актуальные системы компьютерного зрения

Виктор Ерухимов

http://www.itseez.com

itseez

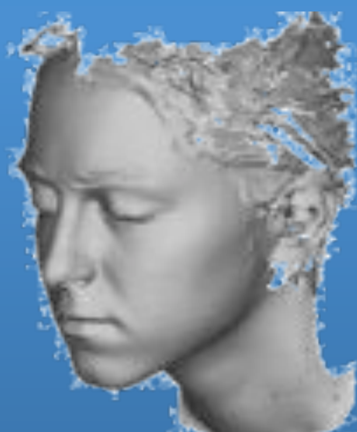
Компьютерное зрение

- Извлечение высокоуровневой информации об окружающем мире из изображений

Computer vision

+

Point cloud



=

Perception

itseez

Vision that works!

http://www.itseez.com

Computer vision dimensions

- **End user applications**
- **Hardware sensors**
- **Computing devices**
- **Algorithms**
- **Software**

Why do we need computer vision?

- Computational photography
- Smart video surveillance
- Biometrics
- Automatic Driver Assistance Systems
- Machine vision (Visual inspection)
- Image retrieval (e.g. Google Goggles)
- Movie production
- Robotics

Computational photography

- High dynamic range imaging

- Object detection

itseez

Smart video surveillance

Need interest operators!

itseez

- Object tracking

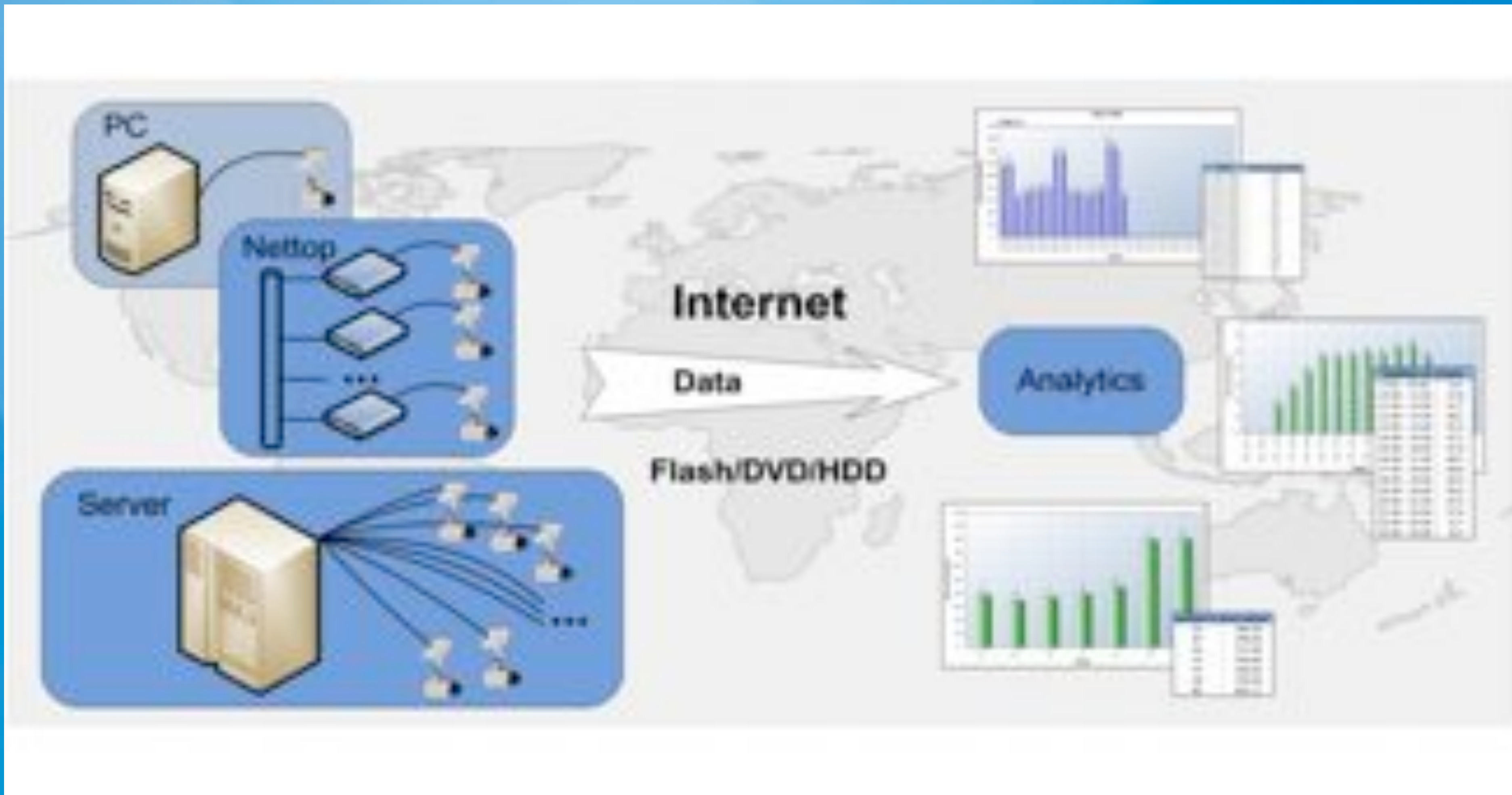
- Car registration

itseez

vCount™ people counter

http://vimeo.com/9830158

vCount™ people counter



http://www.vcount.ru

itseez

vCount™ customers

ЭЛЬДОРАДО

ТЕХНО СИЛА

СПОРТЛАНДИЯ

СЕТЬ СПОРТИВНЫХ МАГАЗИНОВ ДЛЯ ВСЕЙ СЕМЬИ

ТРЭВЭЛЕРС КОФЕ

TRAVELER'S COFFEE

GEOX

RESPIRA

ecco

itseez

Biometrics

- Fingerprint recognition
- Face recognition
- Iris recognition

Facial feature detection

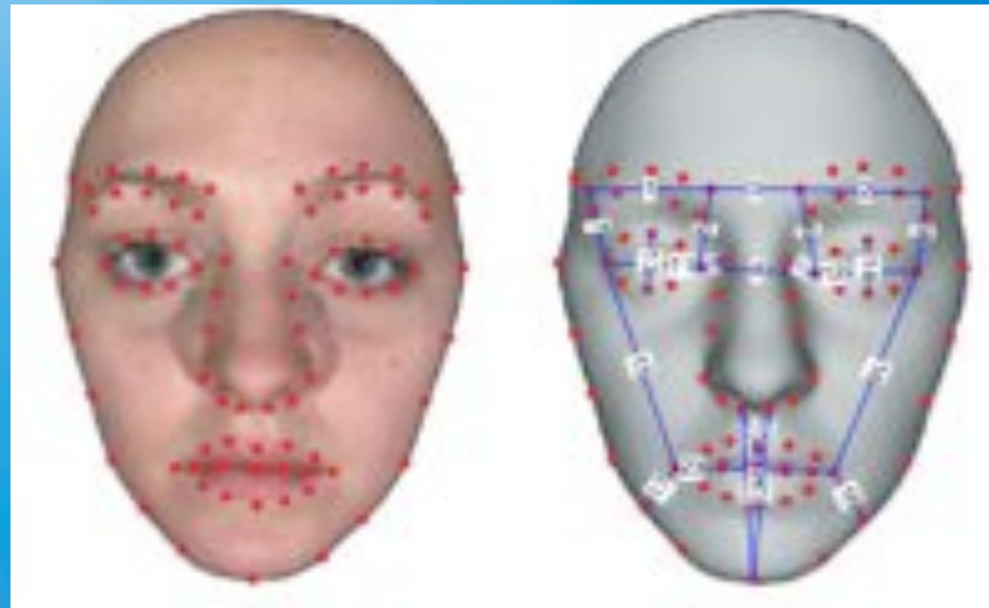


Figure 6. Estimation of roll angle of the face using the location of the eyes. Some faces and the resulting *roll* are shown. Observe that faces can have different expressions.

itseez

Automatic driver assistance systems

- Pedestrian detection
- Lane departure warning
- Forward car collision warning
- Fatigue detection
- Visual odometry for automatic navigation

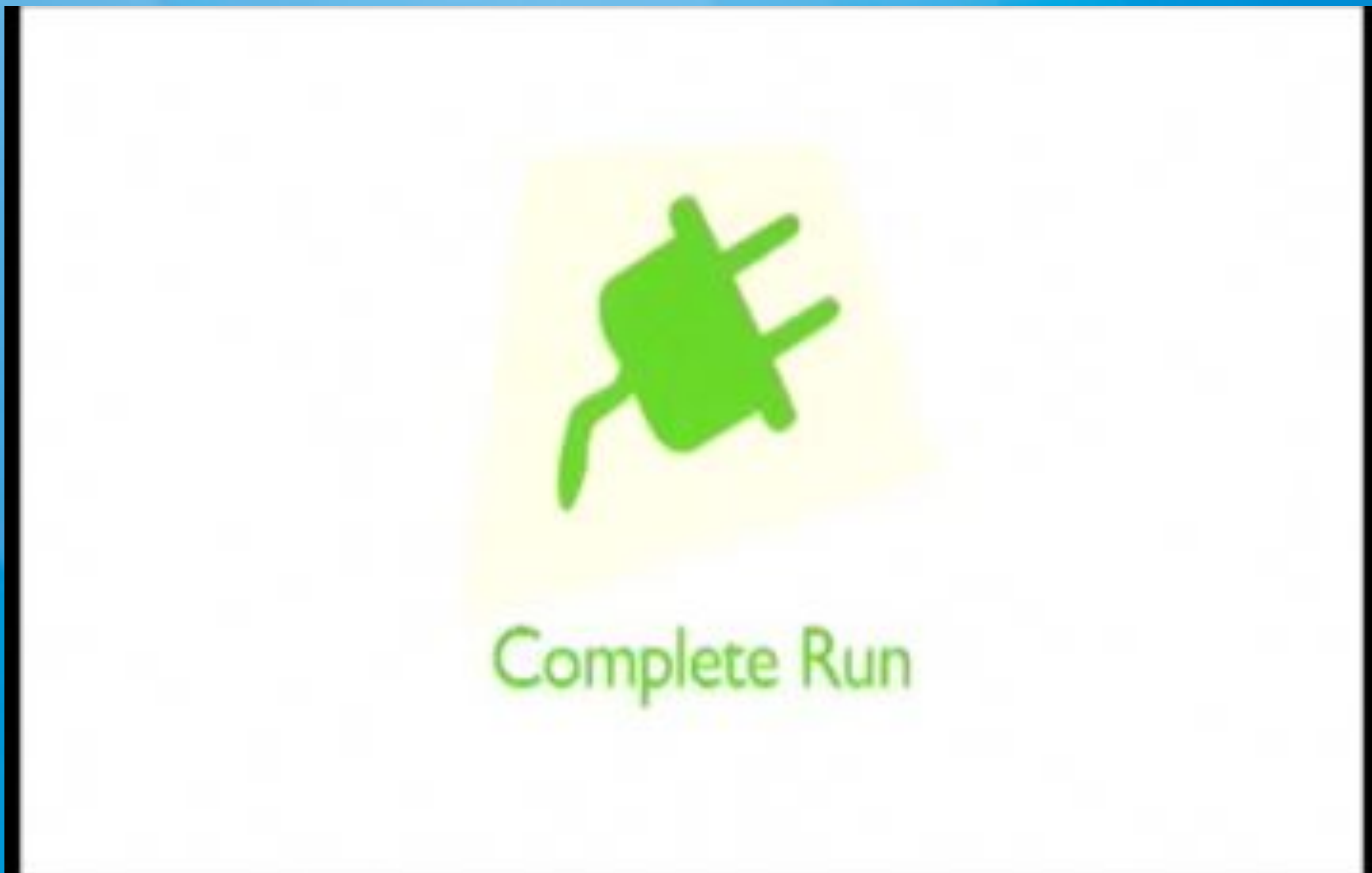
Machine vision

http://www.youtube.com/watch?v=Kks9VI2qhAg

itseez

Robotics

- Navigation
- Grasping
- Human-robot interaction



http://www.youtube.com/watch?v=GWcepdggXsU

itseez

Grasping of transparent objects

Driverless cars

http://www.youtube.com/watch?v=bp9KBrH8H04

Computer vision startups

- ObjectVideo
- IntelliVid
- IntelliVision
- Organic Motion
- Tangam gaming
- PrimeSense
- Like.com
- PolarRose
- Occipital
- Picnik
- PittPatt
- Face.com

In no way complete!

itseez

Computer vision dimensions

- **End user applications**
- **Hardware sensors**
- **Computing devices**
- **Algorithms**
- **Software**

Sensors

- Monocular cameras
  - Analog
  - Digital

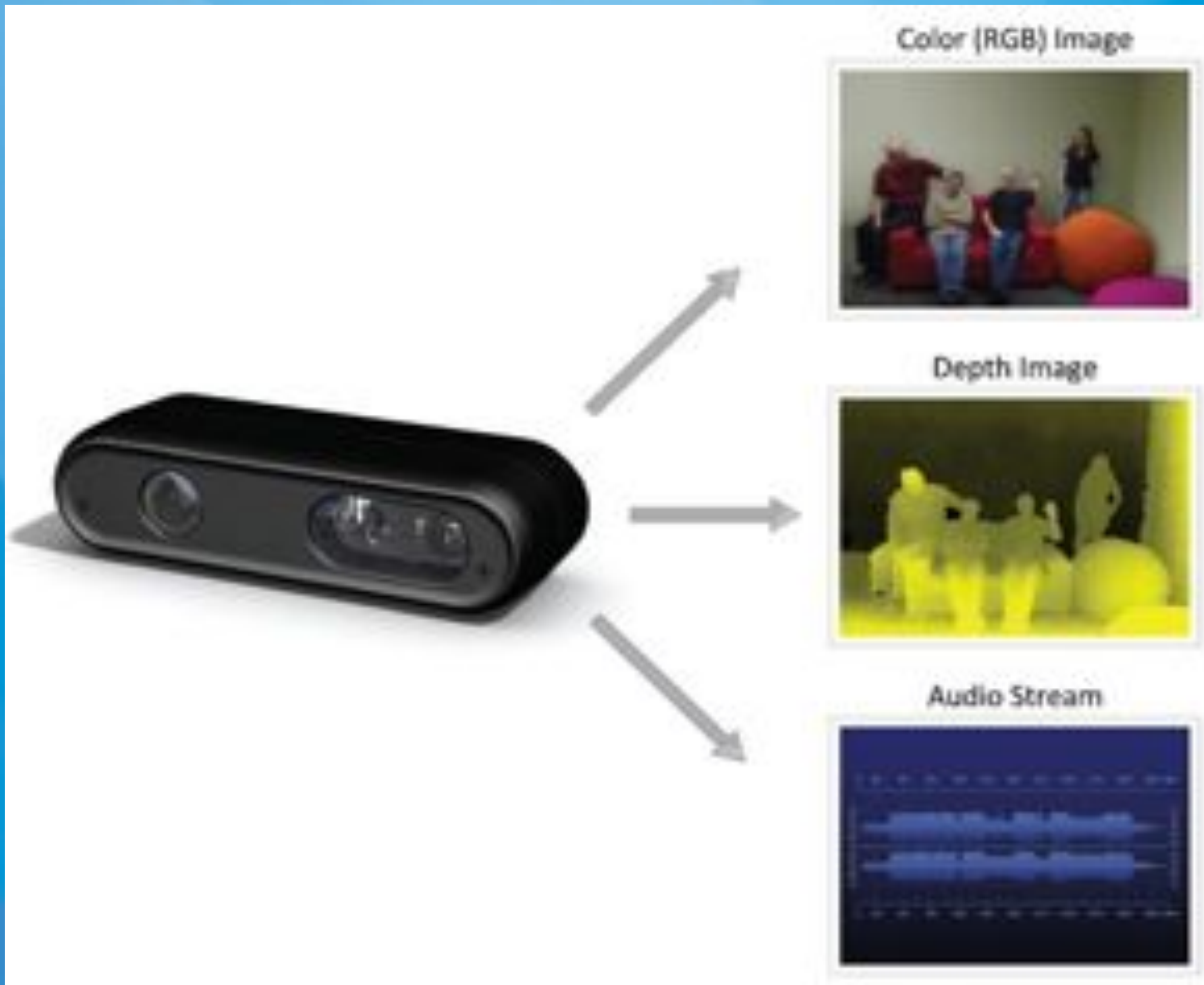
- Stereo cameras

- Structured light devices (PrimeSense)

- Time-of-flight cameras

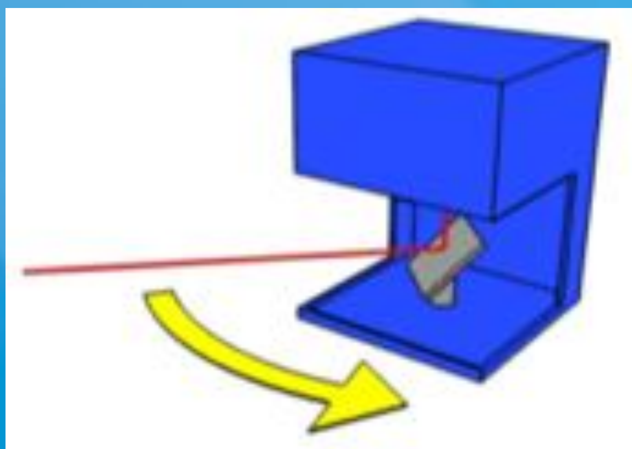
Stereo camera

Structured light sensor



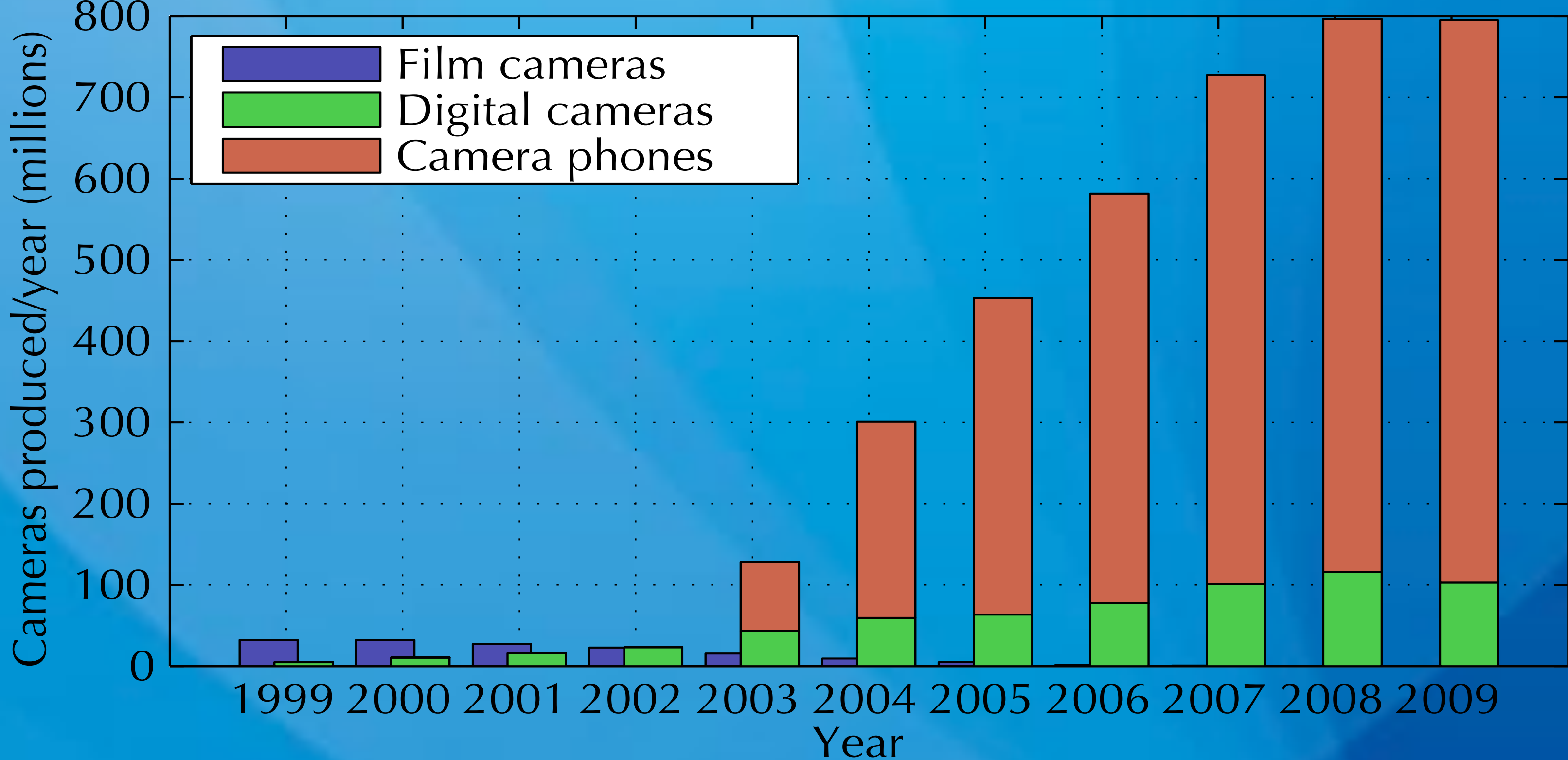
itseez

Lidar



itseez

Mobile is important for CV!



itseez

Sensor fusion

- Sensors of help:
  - GPS
  - Accelerometer
  - Gyro

Computer vision dimensions

- End user applications
- Hardware sensors
- Computing devices
- Algorithms
- Software

Why hardware matters

- Algorithms must be realtime!
- .. And power efficient!

Computing hardware

- Embedded devices
  - FPGA
  - DSP
  - ARM
  - Embedded GPU
- Servers
  - CPU
  - GPU

Computer vision dimensions

- **End user applications**
- **Hardware sensors**
- **Computing devices**
- **Algorithms**
- **Software**

itseez

Software

- OpenCV
- IPP (Intel)
- NPP (NVIDIA)
- IMGLIB, VLIB (TI)
- CoreImage (Apple)
- FastCV (Qualcomm)

OpenCV Architecture

Languages:
- C
- C++
- Python
- Java

Technologies:
- SSE
- CUDA
- TBB

3rd party libs:
- TBB
- IPP
- Eigen
- Jasper
- JPEG, PNG
- OpenEXR
- OpenNI
- VideoInput
- QT

Development:
- Maintainers
- Contributors

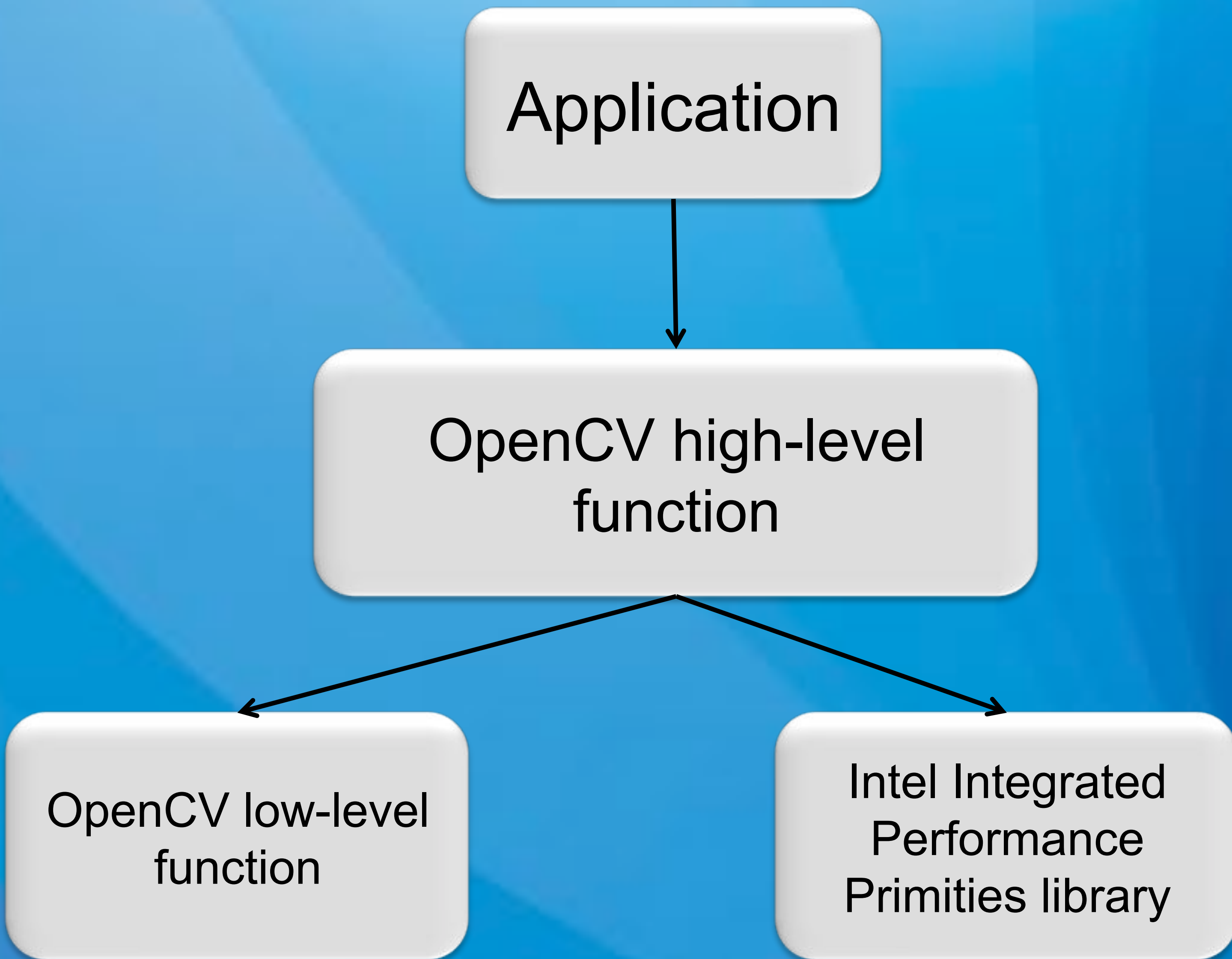
QA:
- Buildbot
- Google Tests

Modules:
- Core
- ImgProc
- Features2D
- Calib3D
- ObjDetect
- Video
- ML
- FLANN
- HighGUI
- GPU

Target archs:
- X86
- X64
- ARM
- GPU

Target OS:
- Windows
- Linux
- Mac OS
- Android
- iOS

OpenCV and hardware: CPU



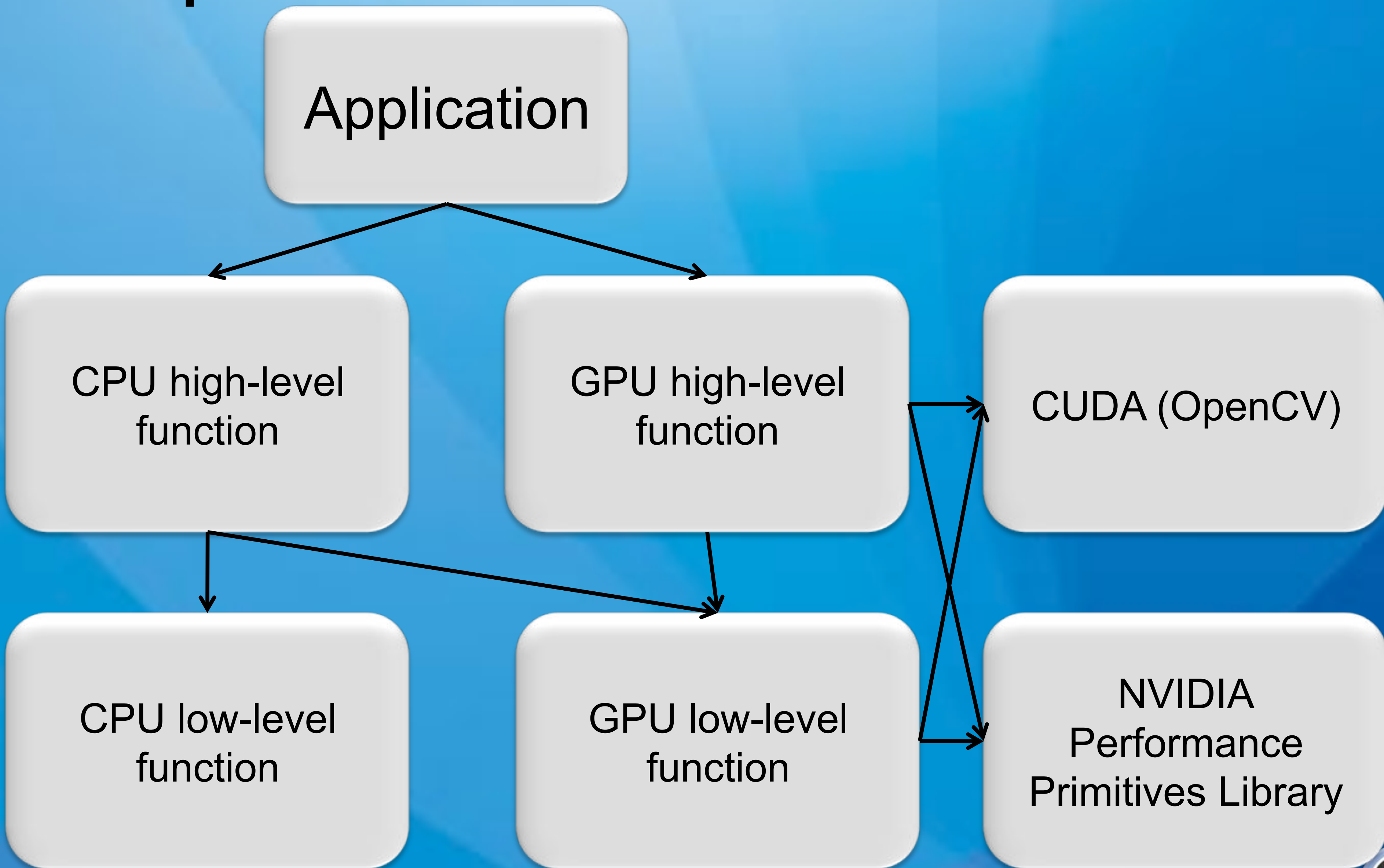
itseez

Hardware optimization: Intel architectures

- arithmetical operations on large matrices/images: add, sub, absdiff - 5-6x faster
- image filtering: e.g. median 3x3 filter is 20x faster!
- geometrical transformations: resize is 2.5 faster
- template matching: 2-2.5 faster
- large matrix processing: SVD of 50x50-1000x1000 matrices is 1.4-2.7x faster

itseez

OpenCV and hardware: GPU



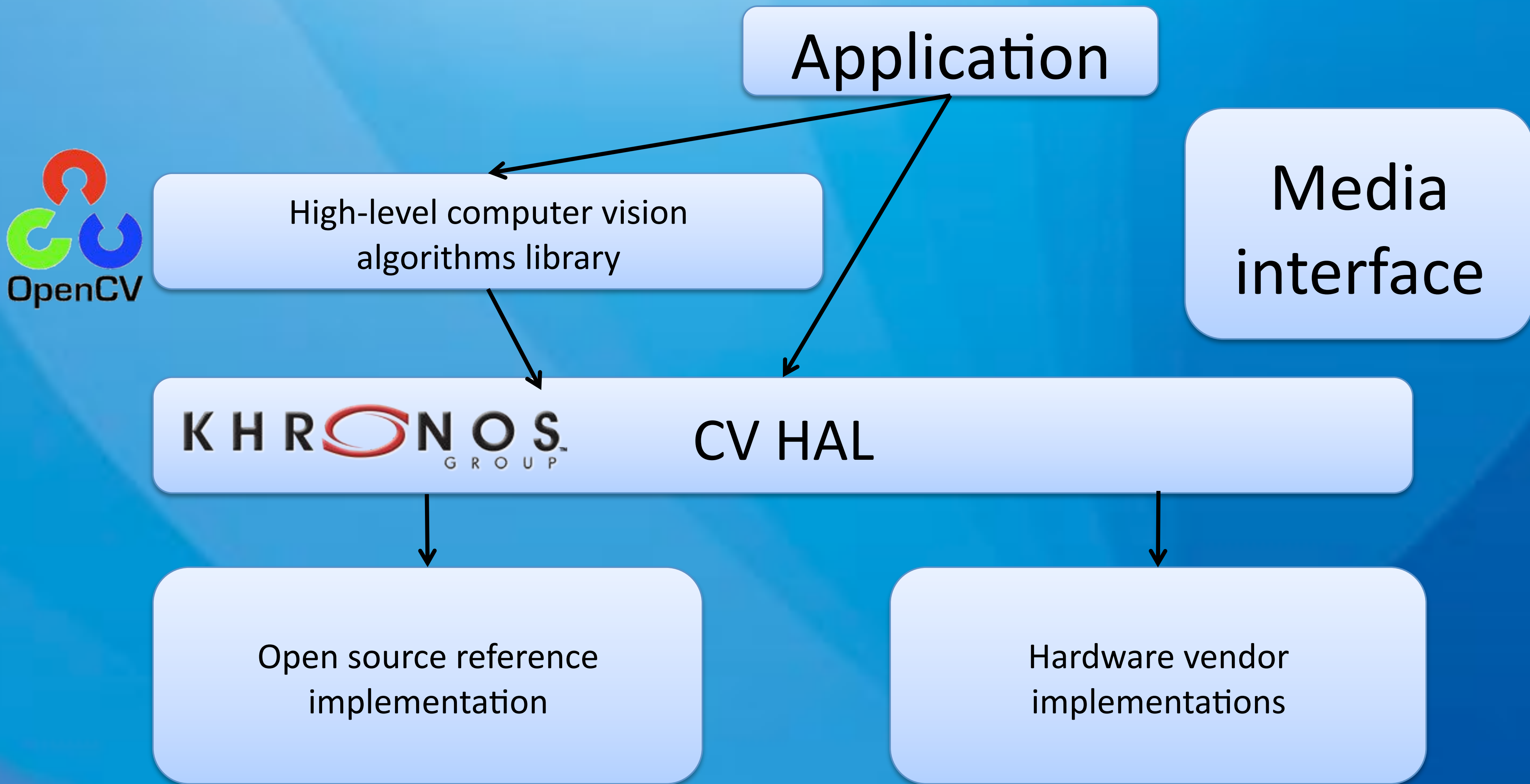
OpenCV GPU Module Performance

- Tesla C2050 (Fermi) vs. Core i5-760 2.8GHz (4 cores, TBB, SSE)

Pipeline	GPU vs CPU speedup
Primitive image processing	**~30x**
Stereo vision	**7x**
Pedestrian detection (HoG)	**8x**
Viola-Jones face detector	**6x**
SURF matching (visual odometry)	**12x**

itseez

Computer vision HAL



itseez

Important HAL issues

- Performance vs power
- Memory model (transparent vs opaque)
- Contents (what to put in)
- Conformance
- Heterogeneous computing

Full-HD stereo in realtime

http://www.youtube.com/watch?v=ThE7sRAtaWU

itseez

Heterogeneous stereo vision

- Image warping
- Correlation function

- Post-filtering

Opportunities

- Google Summer of Code
  - Deadline April 6!
- Internship at Itseez
  - Deadline tomorrow!

itseez

itseez

WE'RE HIRING!

jobs@itseez.com

Q&A