

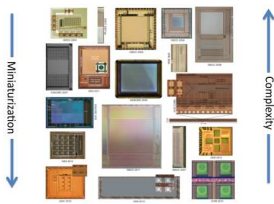
3D Imagers for intelligent devices

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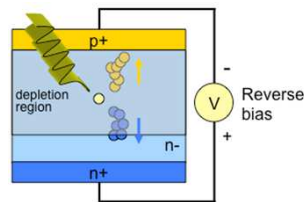
Advanced Quantum Group (AQUA), Ecole Polytechnique Fédérale de Lausanne - aqua.epfl.ch

Single Photon Avalanche Diode

10 years of research (2 EU R&D)

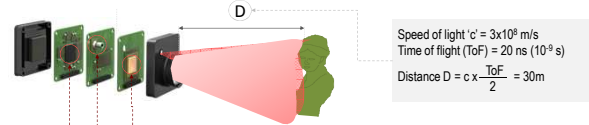


0.35µm to 65nm CMOS (25-15 µm pitch)



Spads for 3D Time-of-Flight

Measuring the time between the generation of a light pulse and the detection of the reflected pulse



Speed of light $c = 3 \times 10^8$ m/s
Time of flight (ToF) = 20 ns (10^{-9} s)
Distance $D = c \times \frac{\text{ToF}}{2} = 30\text{m}$

- Time of Flight processor
- Flexible FPGA design
- Rapid prototyping
- USB3 interfacing
- Pulsed laser / micro LED
- Near Infrared (>800nm)
- Fast switching (< 300ps)
- High repetition rate (<200MHz)
- Long detection range (>30m-50m)
- High resolution (3mm /20ps)
- High frame rate (1'000-10'000 fps)
- Low cost standard CMOS standard manufacturing
- Single photon detector (SPAD)
- Digital measurement (20 ps)

Industrial vision challenges

Autonomous robots, vehicles and machine vision



Requirements

- Safety (lowest ambiguity)
- Speed (10-20m/s)
- Accuracy (>1cm)
- Range (1m-50m)
- Day & low light operation

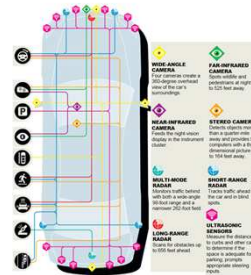
State of arts

- Sensor networks
- Multiple 1D/2D cameras
- Image/video processing
- "Sensor fusion"
- Calibration

Problems

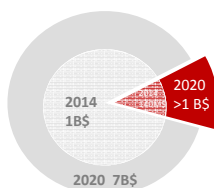
- Complex /slow processing
- Low resolution >10cm
- Ambiguity
- Low range < 15m

Automotive ADAS challenges



- # of cameras : 8
- # of different cameras: 4
- # of additional radars: 5
- Limited at night and poor visibility conditions.
- No good cost effective solution for imaging / sensing for autonomous vehicle in all weather scenarios.

Market Growth



- Addressable 3D vision market
- Total robotic and machine vision market (+automotive 2020)

Robotics / Machine Vision



Integrators



Automotive integrators



3D camera market for driving assistance applications (ADAS)

Fastree3D SA

- Founded in 2013
- Focus: Automotive Machine Vision
- Achievements: 2 prototypes:
 - Line-sensor 256 pixels
 - Array sensor 32x32 p.
- 9 patents
- 5 employees (2 FTEs)
- Business Model: B2B Licensing (2014), B2B Product: ToF camera (2016)