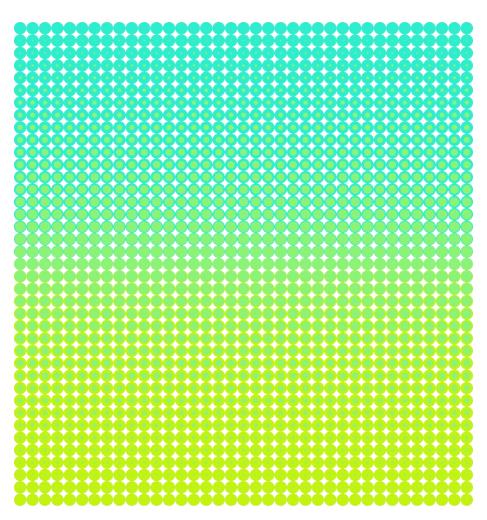# Enhancing safety with quality 2D/3D Vision

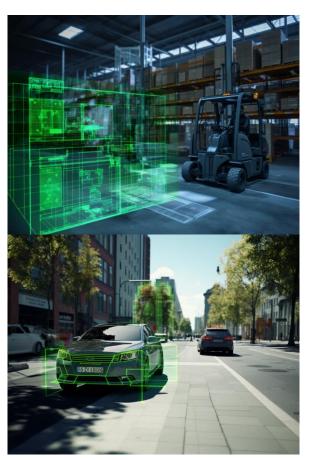12.09.2023

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∗fastree 3D

Content

- Definition of safety in LiDAR sensors
    - Robotics
    - Automotive
- Features of a safe LiDAR
- Fastree3D Alopex LiDAR
    - Features
    - Functions
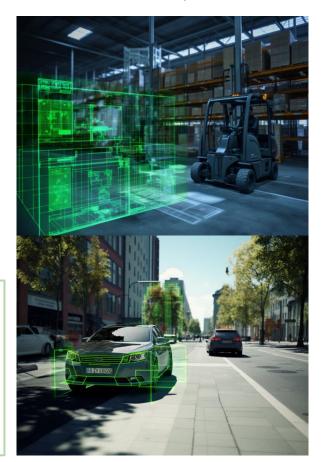   - Architecture
    - Reference design and development kit

LiDAR safety definition

Safety for industrial and automotive LiDAR?

LiDAR safety definition

Safety for industrial and automotive LiDAR?

- **Accuracy and resolution**
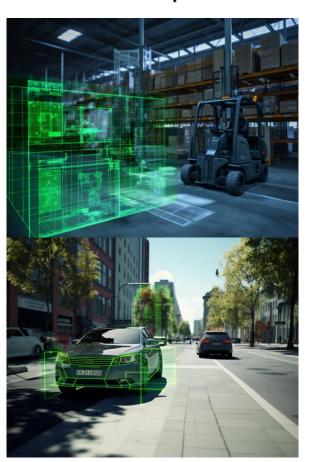
→ Measure the volume, shape, and movement of objects in 3D space.

→ Object recognition and classification

→ Object tracking

LiDAR safety definition

Safety for industrial and automotive LiDAR?
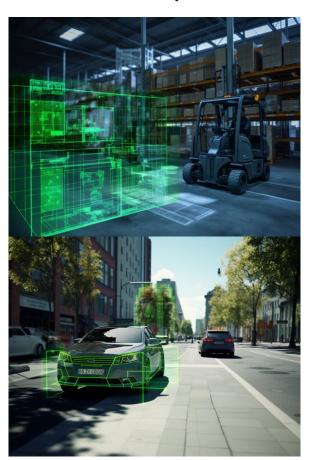
- Accuracy and resolution

- **Repeatable measurements**

→ Repeated measurements in the same conditions must yield the same results.

→ No need to repeat measurements

→ Decisions can be taken with a single snapshot

→ Low latency between measurement and action

LiDAR safety definition

Safety for industrial and automotive LiDAR?

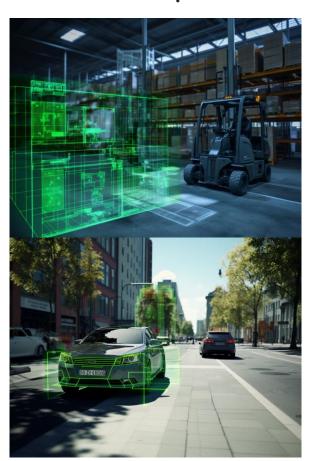- Accuracy and resolution

- Repeatable measurements

- **Robustness**

→ Resilience against external and environmental influences

→ Ambient light, sunlight

→ Optical interference (multicamera)

→ Ambient temperature

LiDAR safety definition

Safety for industrial and automotive LiDAR?

- Accuracy and resolution

- Repeatable measurements

- Robustness

- **Quantifiable measurement quality**

→ Evaluate the quality of each pixel measurement

→ In real time

→ Avoid false positives and false negatives

Better vision for safety and automation

✳ **fastree 3D**

Fast
Emergency collision
avoidance in city traffic

10 ms
~ 15cm reaction

⊙ Lowest latency

Safe
Low false detections
under adverse visibility

Interferences   60 Klux

☀ Quality control

Software-defined
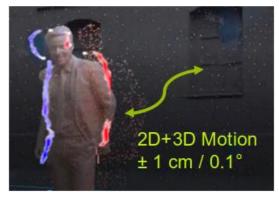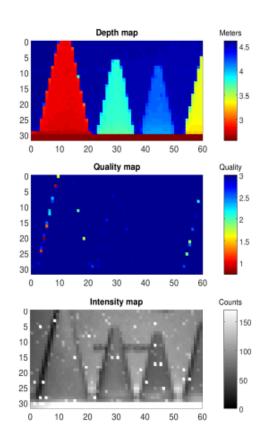Actionable 3D + 2D
information for automation

2D+3D Motion
± 1 cm / 0.1°

⬡ On-chip processing

Rich measurement information: 3D + 2D + QoR

*fastree 3D

Depth map (3D):
- Matrix of pixel data providing distance to objects.

Quality map:
- Matrix of pixel data assessing the reliability of the distance information (0: low, 3: high). **False positives and false negatives avoided.**

Intensity map (2D):
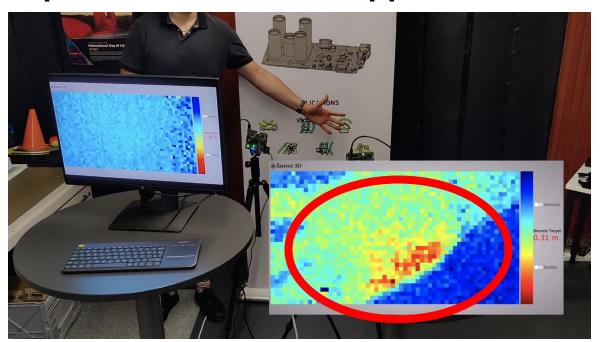- Gray-scale image of the scene.

Ambient Light Suppression

✳ fastree 3D

Major issue in outdoors applications

- SNR reduction
- Saturation
- Dynamic range!

Countermeasures are necessary to operate up to 100 klux ambient illumination

→ Optical bandpass filters
→ ND filters
→ Sensitivity modulation
→ Time gating and exposure time
→ Photon Coincidence
→ Depth resolution

Optical Interference Suppression

1 Paper published
2 Patents

Two LiDAR in the same room.

- Wrong distance measurement
- No a-priori indication of interference
- Ghost images
- Missing images

FLISS algorithm
- No interference (-51dB)
- No coordination
- No communication
- Arbitrary number of devices
- Works with any LiDAR

Alopex LiDAR key specifications

C1100 "Alopex"

✳fastree 3D

➢ Pixel resolution: 256 x 64 (512 x 128 super-resolution mode available)
➢ Depth resolution: 1 cm
➢ Framerate: < 300 fps
➢ Control interface: I2C (I3C)
➢ Data interface: MIPI CSI

Other features

➢ Ambient light suppression (60 klux)
➢ Optical interference suppression (multicamera ready)
➢ Software-defined behaviour
➢ Integrated laser controller (4 independent channels)
➢ Rolling shutter and global shutter
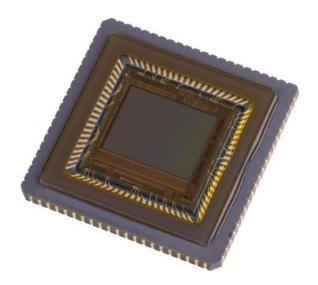➢ Embedded Quality of Result
➢ Intensity imaging
➢ Region of interest

Figure for illustrative purposes only, not depicting the actual product.

Alopex LiDAR functions

C1100 "Alopex"

✳ fastree 3D

➢ **Photodetection and ToF measurement**
  ○ SPAD-based pixels and integrated TDCs

➢ **Software-controlled**
  ○ Real-time access to configuration and operation parameters, I2C/I3C

➢ **Laser control**
  ○ Programmable sequencer, synchronization, 4 independent sources

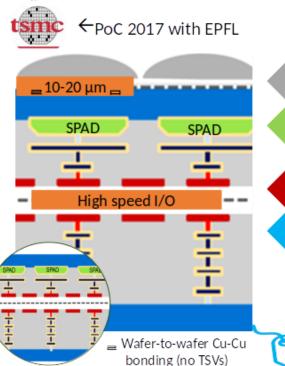➢ **Integrated data processing**
  ○ Point cloud, intensity, QoR

➢ **Data interface**
  ○ Standard MIPI CSI v2.1

State of the art technology partnerships

✳ **fastree 3D**

Hybrid bonded circuit

tsmc ←PoC 2017 with EPFL

10-20 μm

SPAD   SPAD

High speed I/O

SPAD SPAD SPAD

◀ Micro-lenses

◀ Single-photon detection (SPAD)

◀ Pixel- connections

◀ Processor chip
- Timestamping
- S/N processing
- Laser control

≡ Wafer-to-wafer Cu-Cu bonding (no TSVs)

BoM 20$

Industrial support

- *We support intelligent imaging and sensing*
  Avi Strum, GM, Sensors

  Tower Semiconductor   intel foundry services

- *We foresee industrial market opportunities.*
  Markus Rossi, VP Innovation

  amuั   OSRAM

- IP block support (I/O, PLL)

  miXel   Anatrix INTEGRATED CIRCUITS   MOSCAD

Falcon Hardware Development Kit

Development Kit
Q4'2022 (HDK)

- CPU/GPU + FPGA
- 60 x 32px >30 fps
- Gb E, CAN, USB
- OSRAM
- Point cloud +2D +Qual.

ADAS engineering
H2'2023 (NRE)

SR-Lidar 2x 30° / 30m
Daylight lamp PoC

NVIDIA DRIVE

AUDI NVIDIA BOSCH NXP Valeo

Industrial safety chip
2023-2024 (NRE+ samples)

Industrial safety

Infrastructure security
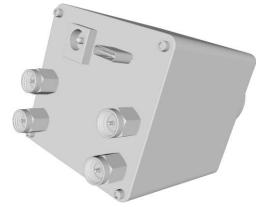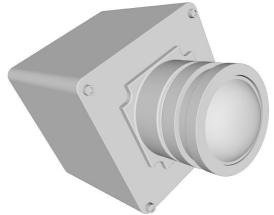
Alopex reference design

- Fully featured Alopex LiDAR chip

- 5x5x5 centimeter form factor alu case

- Integrated power and bias generation

- Up to 4 independent external illuminators

- Option for an integrated internal illuminator

- Standard C(S)-mount for optics

- Standard I3C control interface

- Standard MIPI CSI data interface

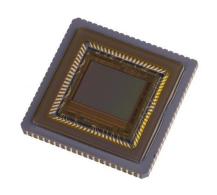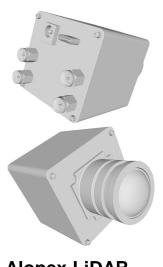- DC 12V power input

Released: Q3 2024

Open project areas

Alopex IC

→ Specifications
→ Certification
     > SIL-x
     > ASIL-x
     > …

Falcon Devkit

→ Pilot projects
                 > Industrial automation
          > Robotics
          > Automotive safety
          >

Alopex LiDAR

→ Early adopters
→ System integration
→ Eye safety
→ Embedded software

Thank you for your attention!

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