



The Sensor Pioneers.

SWISS PHOTONICS

HTW Chur

Hochschule für Technik und Wirtschaft
University of Applied Sciences



3D Sensors for Transportation Systems

June 21st, HTW Chur, Industrial 3D Vision

Christian-Erik Thöny, CEO CEDES Group

What if?

we could



Replace light curtains by a sensor that is 40 times smaller

yet simultaneously adding a completely new intelligent dimension with benefits such as

- entrance area monitoring, accurate
- people counting, preventive maintenance,
- UCM prevention, etc.

EN81-50 fulfilling and having the potential to be SILx certified



The Sensor Pioneers.



We change Sensor Technology

CEDES develops intelligent, safe sensor solutions on highest quality level. We strongly believe in changing the world going 3D sensor technology which adds unequaled value.

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Mega Trend IoT drive sensor market

Trillion Sensor Visions

- 22%/Y
- 21%/Y
- 12% year slope
- "Abundance"
- QCOM Swarm Lab, UCB
- Bosch
- Hewlett-Packard
- Intel
- TI internet devices
- Yole MEMS Forecast, 2012
- Sensors Bryzek's Vision
- Mobile Sensors Explosion

With a Trillion Sensors, the Internet of Things Would Be the "Biggest Business in the History of Electronics"

2011 – 2022 market forecast 3D imaging and sensing, including automotive

16.6 Bn \$

37.7% CAGR

Revenue (\$B)

Consumer Transport Medical Industry/Commercial Scientific/Defense/Space

(Yole Développement, April 2017)

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Time of flight TOF Technology

3D time-of-flight measurement

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3D sensors; way off higher intelligence

▶ conventional door safeguard with light curtains

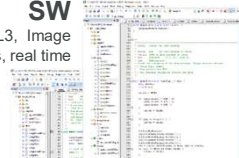
➔

▶ 3D-sensor with additional features, extended safeguard, pre area monitoring, people counting,

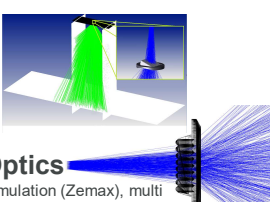
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3D sensors interdisciplinary challenge

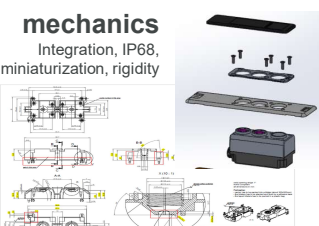
SW
Bare-Metal, SIL3, Image processing, features, real time



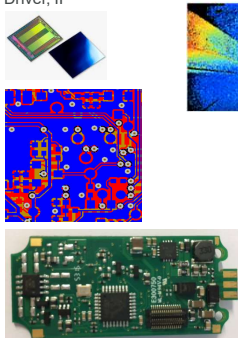
Optics
Simulation (Zemax), multi lens, diffractive elements (sinus gratings), eye safety



mechanics
Integration, IP68, miniaturization, rigidity



HW
Power Mgmt., Imager, Illumination, CPU, Driver, IF



Robust signal
Features inside
Highest quality
Certified (SIL3)
Low cost

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3D sensors tough TOF parameters

Impact on real distance by many parameters:

- Pixel non uniformities
- Artefacts
- Temperature
- Ambient light
- Mirroring superimposing
- Cross talk
- Illumination errors

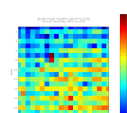


Figure 4: Horizontal strip due to row addressing variation

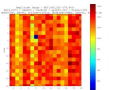


Figure 5: Column fix pattern noise

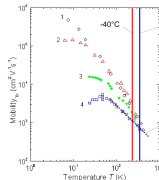


Figure 6: Electron velocity in various Silicon types as a function of temperature, electrical field strength

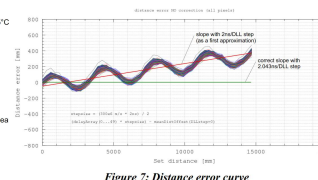


Figure 7: Distance error curve

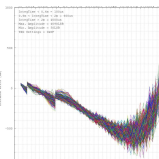


Figure 11: No ambient light compensation

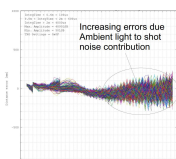



Figure 12: Ambient light compensation. Note the ambient light shot noise at longer distances with lower amplitude.



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TÜV tough TOF certification



After all calibrations / compensations:

- Real life mirroring by e.g. elevator door blades and bottom plates
- Big objects are managed
- Small EN81-20 test rod (50 mm) not anymore
- TÜEV requests this object, certifying only if managed

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High resolution/accuracy true 3D sensor



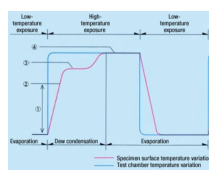
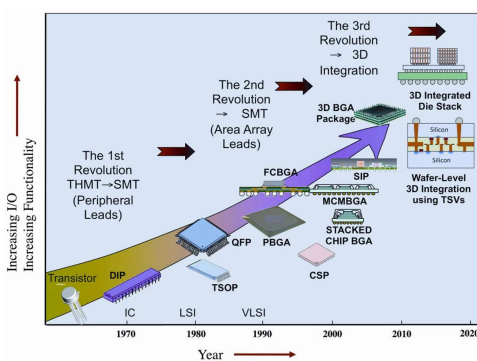
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Problem resolved?



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We are not ready to sell

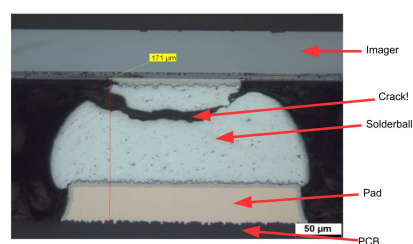
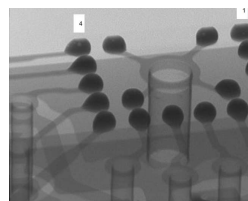
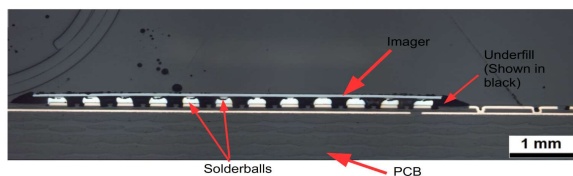


Higher integrated IC require higher HAST / HALT tests according JEDEC => very demanding shock tests
All successfully done
Japanese OEM even tougher



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Failure analysis on chip assembly level



Solder ball cracked:

- JEDEC standard; passed all tests
- According higher Japanese tests cracks occurred in a few samples
- Over days from +80°C to -20°C within one second
- Various measures necessary; but resolved

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Quality production necessary



Swiss quality. With highest care and precise, 3 times 100% control. Conscientious and reliable. That's what we stands for.

Magic: <1'000 PPM

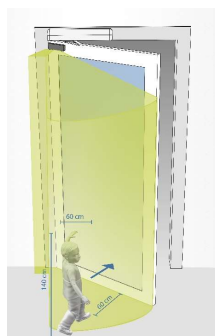


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TOFswing – Safety Sensor

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- ▶ TOFswing safeguards automatic doors' opening and closing area
- ▶ New opportunity smart opening
- ▶ **Smallest sensor, easiest installation, best in class safeguarding, potentially smart opening, lowest cost (high CM)**



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Fahrtreppen

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Conclusions



- 3D monitoring technology goes solid state (cost effective)
- TOF time-of-flight is disruptive, complete new approach
- TOF sensor technology opens undreamed-of opportunities
- Development requires a highly skilled / experienced interdisciplinary staff, working at the edge of physics
- Robustness is key (environment!); challenged by TUEV (design, 50 mm test rod), even more in reality (Japan)
- Consistent quality in PPM order of magnitude is key
- Pretty cool stuff

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