



## 3D Camera as Smart Surveillance Sensors

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# A few words about ESPROS



## Locations

- Sargans, Switzerland (est. 2006)
- USA, China



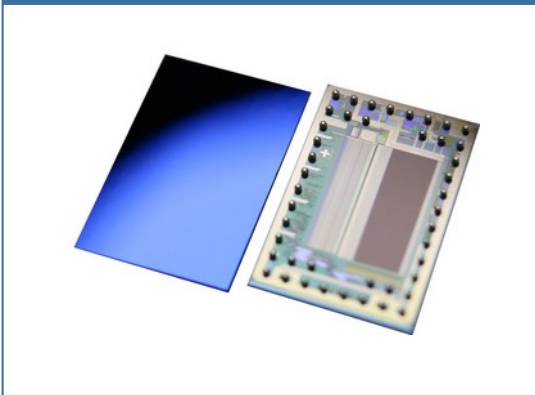
## Activities

- Design and manufacturing of photonics chips and TOF cameras
- Sales in 2021
  - >10k 3D TOF cameras sold in 2021
  - >500k camera chips sold
  - >15m chips sold in 2021

# ESPROS' Offerings

## Key offerings

### Standard Chips



### ASIC and Foundry



### Modules




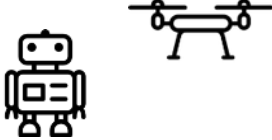
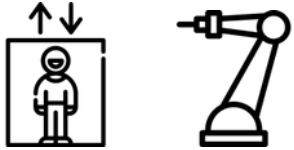
## Selected key features

- TOF 8 x 8
- TOF 160 x 60
- TOF 320 x 240
- Line Imager 1024 x 1
- Photo diode amplifiers
- Photo diode arrays
- High voltage output switches
- Spectral sensing

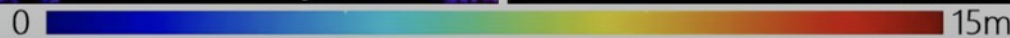
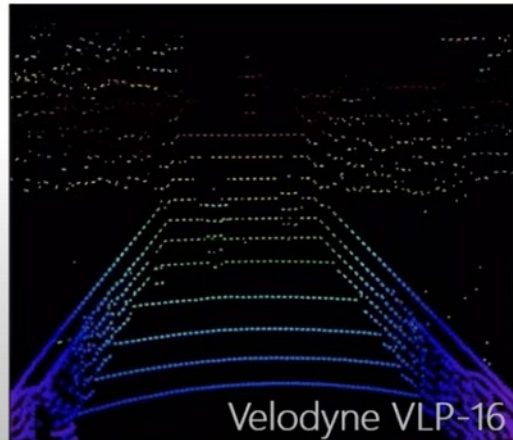
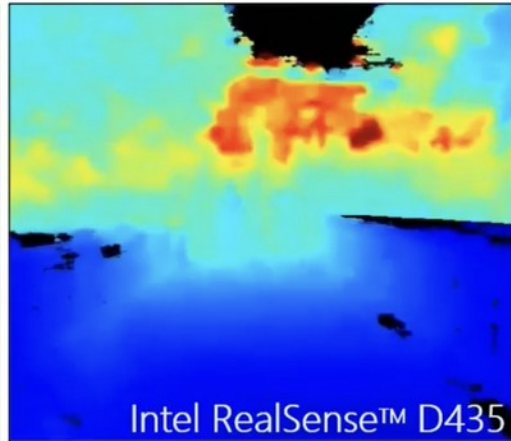
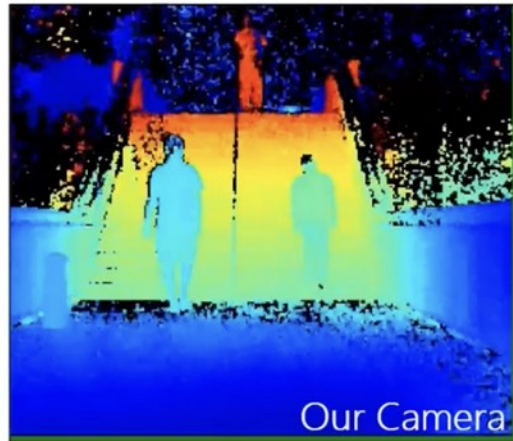
- 150nm CMOS process
- 8" wafer size
- 6 metal layers
- 1 poly layer
- 1V8 core, up to 12V mixed signal
- Photonics ASIC, focused on
  - cwTOF
  - pTOF / LiDAR
  - TDI imaging
  - Ultrafast imaging
- Pixel design
- TCAD simulation
- IP building blocks
- Project management
- PDK for Cadence design environment

- TOFrangle-611
- TOFcam-611
- TOFcam-635
- TOFcam-660
- Custom modules

# ESPROS' Key Markets

Markets	Automotive	Mobile Robotics	IoT / Automation
<b>Technical Capabilities</b>			
<b>Applications</b>	<ul style="list-style-type: none"> <li>• Long range LiDAR: &gt;250m</li> <li>• High resolution: better 0.05°</li> <li>• High frame rate: &gt;100 fps</li> <li>• At full sunlight and at night</li> <li>• QE&gt;70% at 905 nm</li> </ul>	<ul style="list-style-type: none"> <li>• cwTOF</li> <li>• pTOF/LiDAR</li> <li>• Low power</li> <li>• Flash and scanning</li> <li>• SLAM</li> </ul>	<ul style="list-style-type: none"> <li>• cwTOF</li> <li>• CCD technology</li> <li>• Imaging with up to 20 Mfps</li> <li>• Very high near infrared sensitivity</li> <li>• High sensitive photodiode amplifiers</li> <li>• Low cost photodiode arrays</li> </ul>
	<ul style="list-style-type: none"> <li>• Autonomous vehicles</li> <li>• Driver assistance systems</li> <li>• Long range LiDAR sunlight</li> <li>• High resolution</li> <li>• Object classification</li> <li>• Night vision</li> <li>• In-cabin monitoring</li> <li>• Gesture control</li> <li>• 360° surround view</li> <li>• Driver monitoring</li> </ul>	<ul style="list-style-type: none"> <li>• Obstacle collision avoidance</li> <li>• Step sensing</li> <li>• Camera auto-focus</li> <li>• Hospitality and retail robots</li> <li>• Household robots</li> <li>• Consumer and security drones</li> <li>• Delivery robots</li> </ul>	<ul style="list-style-type: none"> <li>• Rotary and linear encoder</li> <li>• Triangulation</li> <li>• Surface scan</li> <li>• Silo monitoring</li> <li>• TDI imaging</li> <li>• Nursing home monitoring</li> <li>• People counting</li> <li>• Automatic door sensors</li> <li>• Elevator door sensors</li> </ul>

# See the difference



This comparison clearly shows why our technology has achieved a breakthrough for outdoor applications. The study was independently carried out by the Carnegie Mellon University in Pittsburg/USA (<https://www.cmu.edu>).

# 3D camera as a surveillance sensor: Nursing home use cases

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## 3D camera as a surveillance sensor: Nursing home use cases



Source: <https://www.nursinghomeabuseguide.org/news/what-to-look-for-with-nursing-home-accessibility/>

## Trends

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- The aging population increases
- Available professionals is decreasing
- Automation is required to reduce the number of professionals



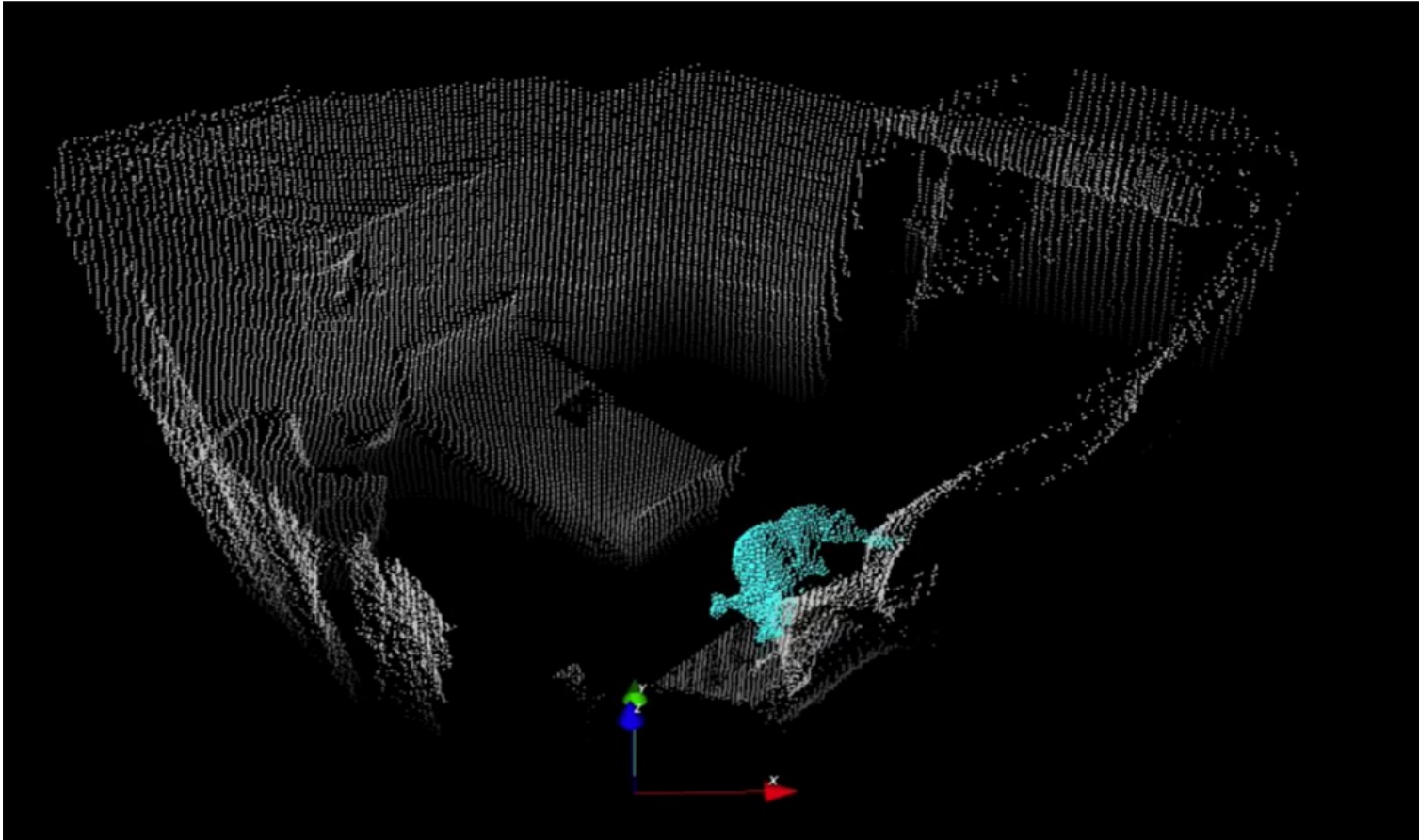
## Current Situation

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- At night, nurses visit the residents approx. every 3 hours
- In between these visits, no real time information is available
- Thus, undiscovered incidents can occur and can lead to a fatality

## Undiscovered falls

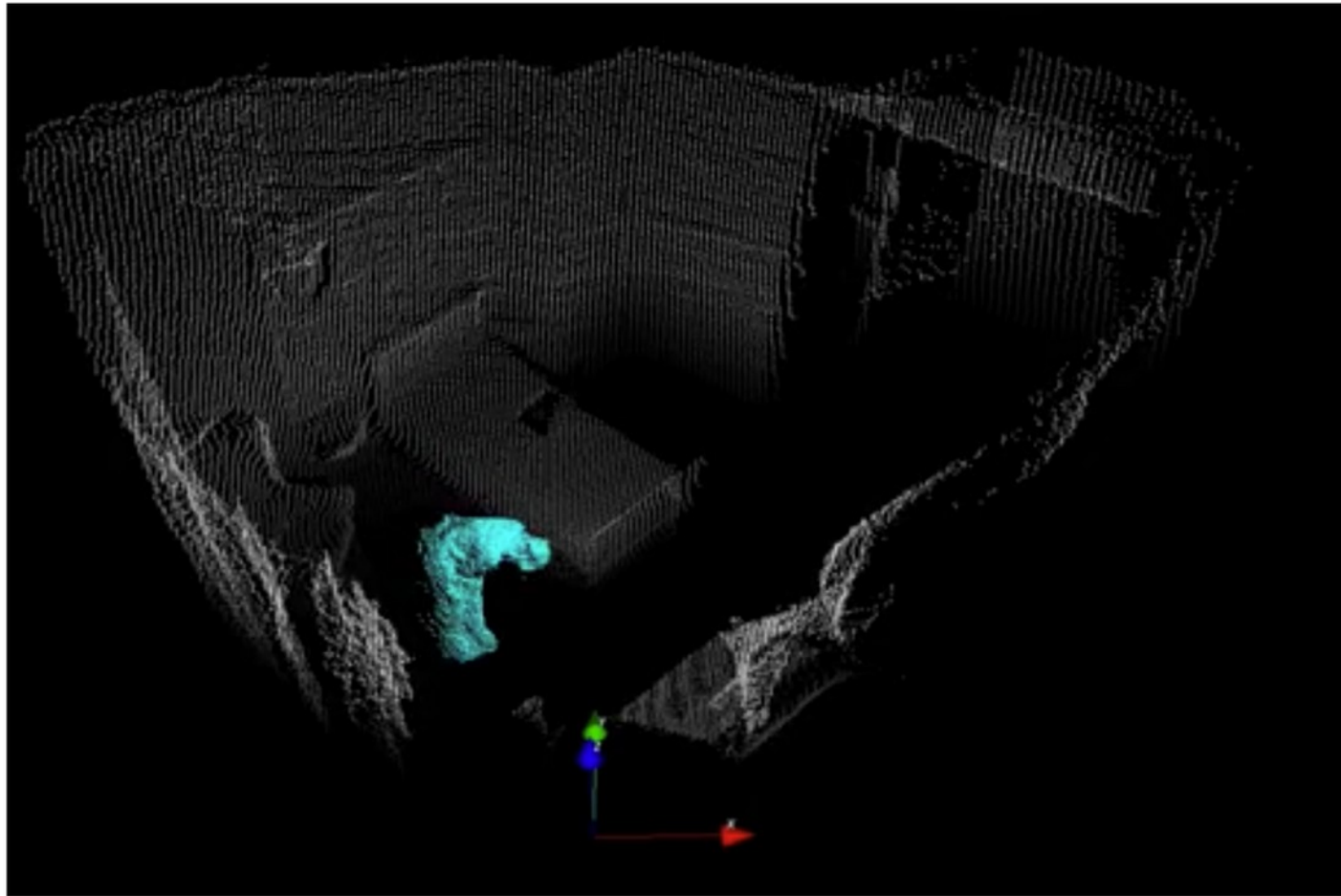
**One in two persons aged  
over 75 has a fall every year!**



Source: Kaspard, 36, rue boulevard du souverain, 1170 Bruxelles, Belgium

## Wandering

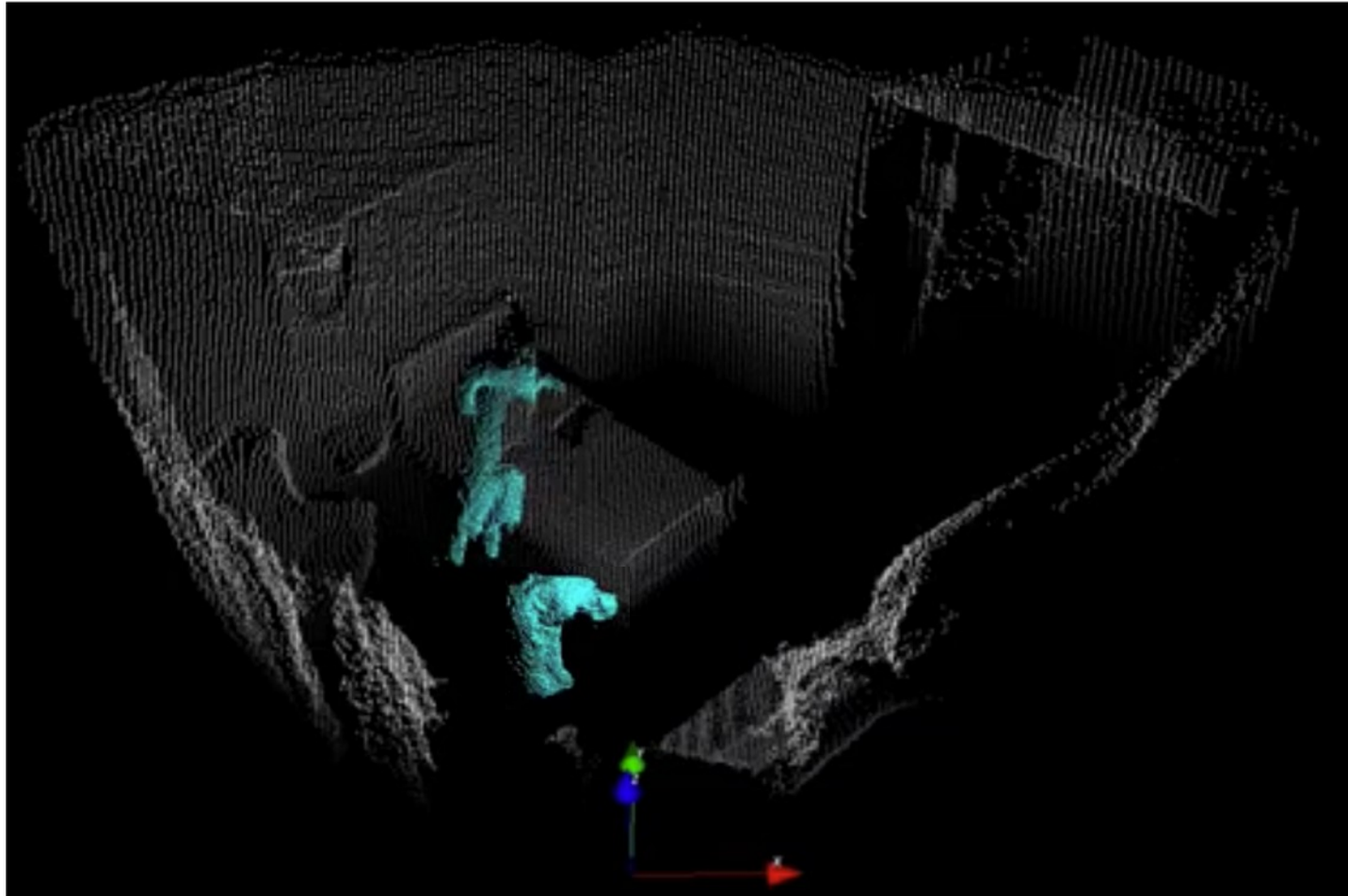
**Residents wander around too long,  
become anxious and get exhausted.**



Source: Kaspard, 36, rue boulevard du souverain, 1170 Bruxelles, Belgium

# Intrusion

## Unwanted visits to the other rooms

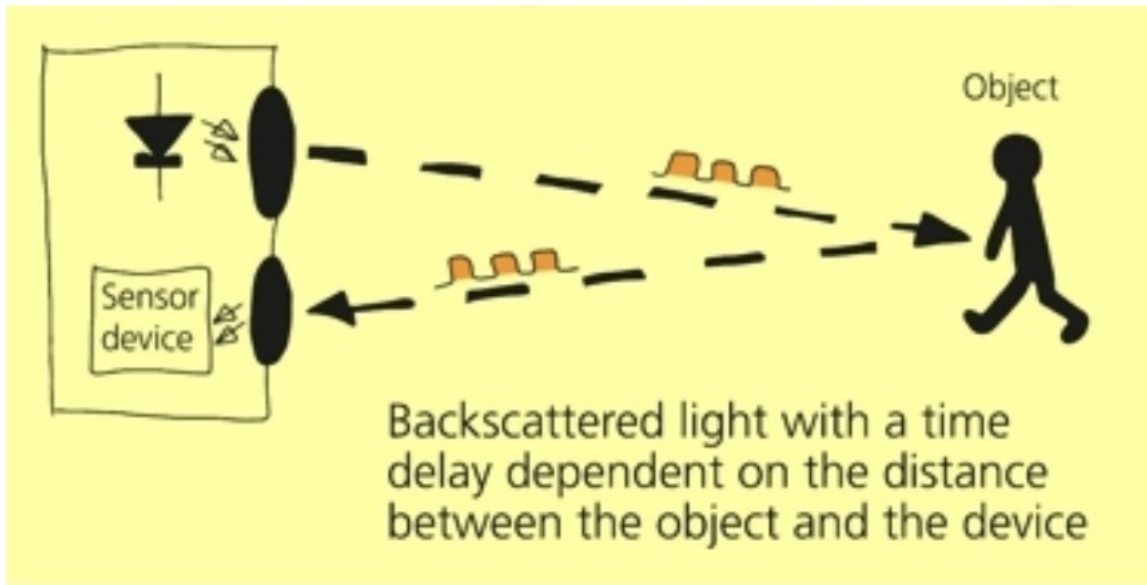


Source: Kaspard, 36, rue boulevard du souverain, 1170 Bruxelles, Belgium

# How to implement nursing automation?

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## Use a 3D Camera

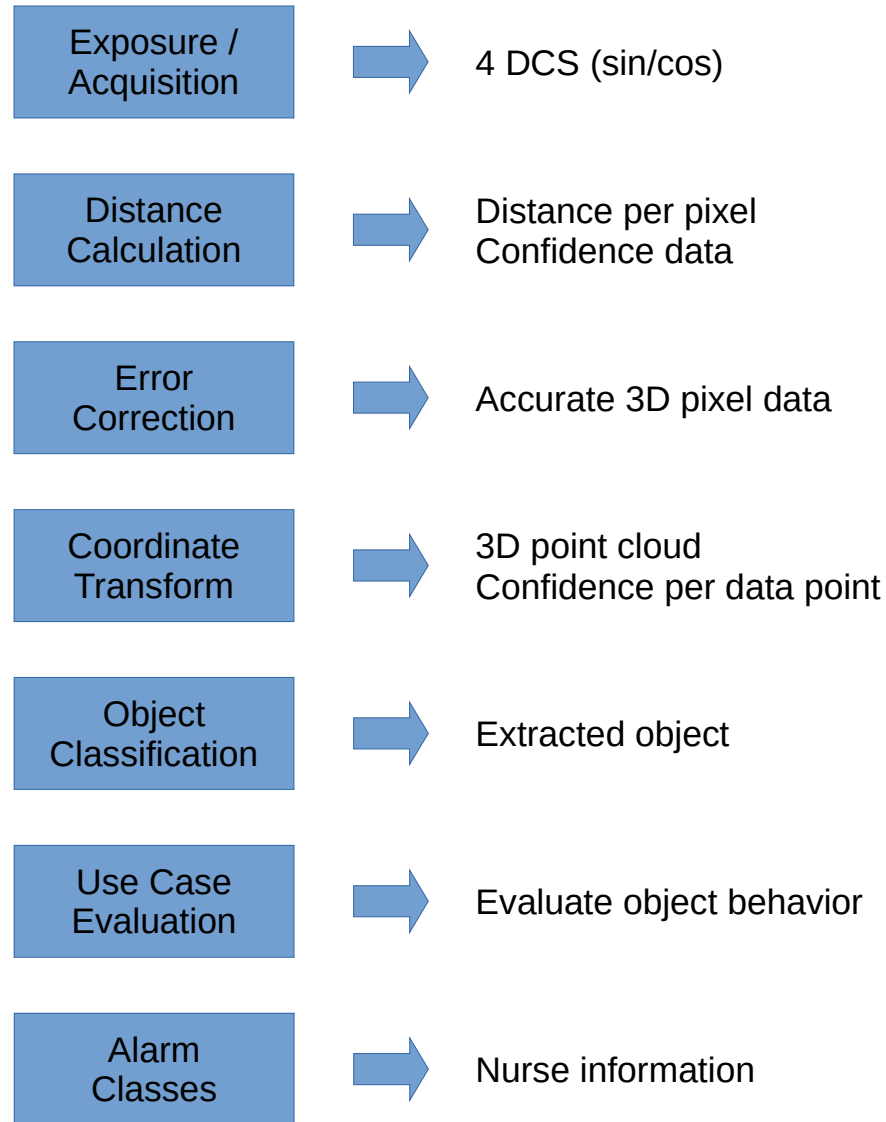


Source: ESPROS Photonics AG

# How does it work?

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# Camera Operation: 7 Steps Processing Pipeline



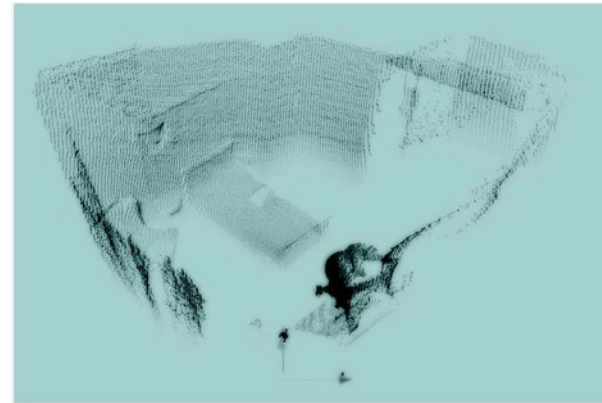
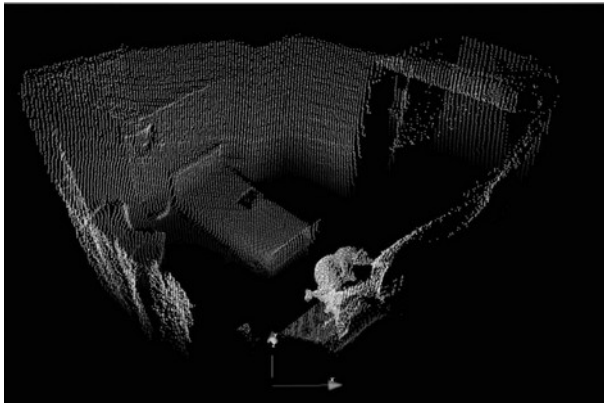


# DCS Acquisition

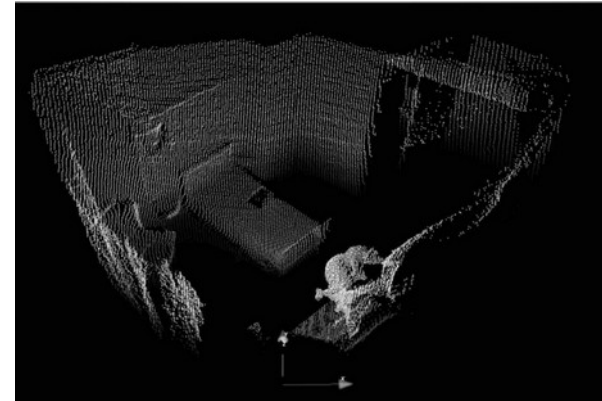
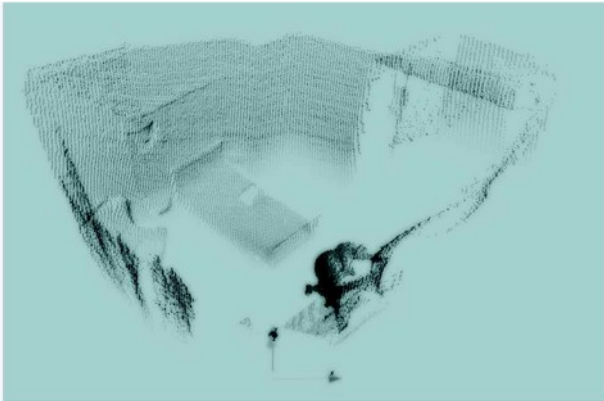
0°

180°

SIN

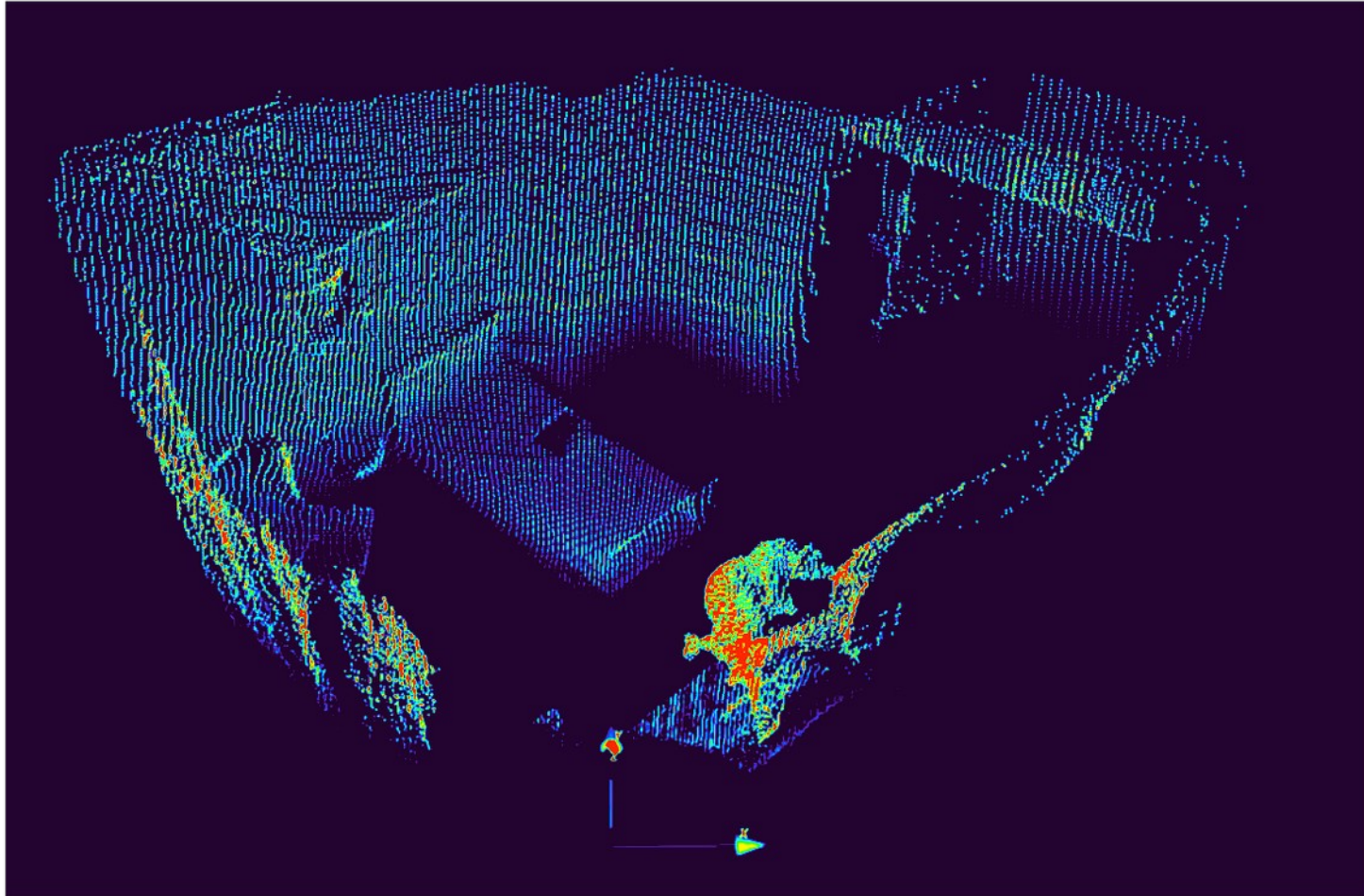


COS



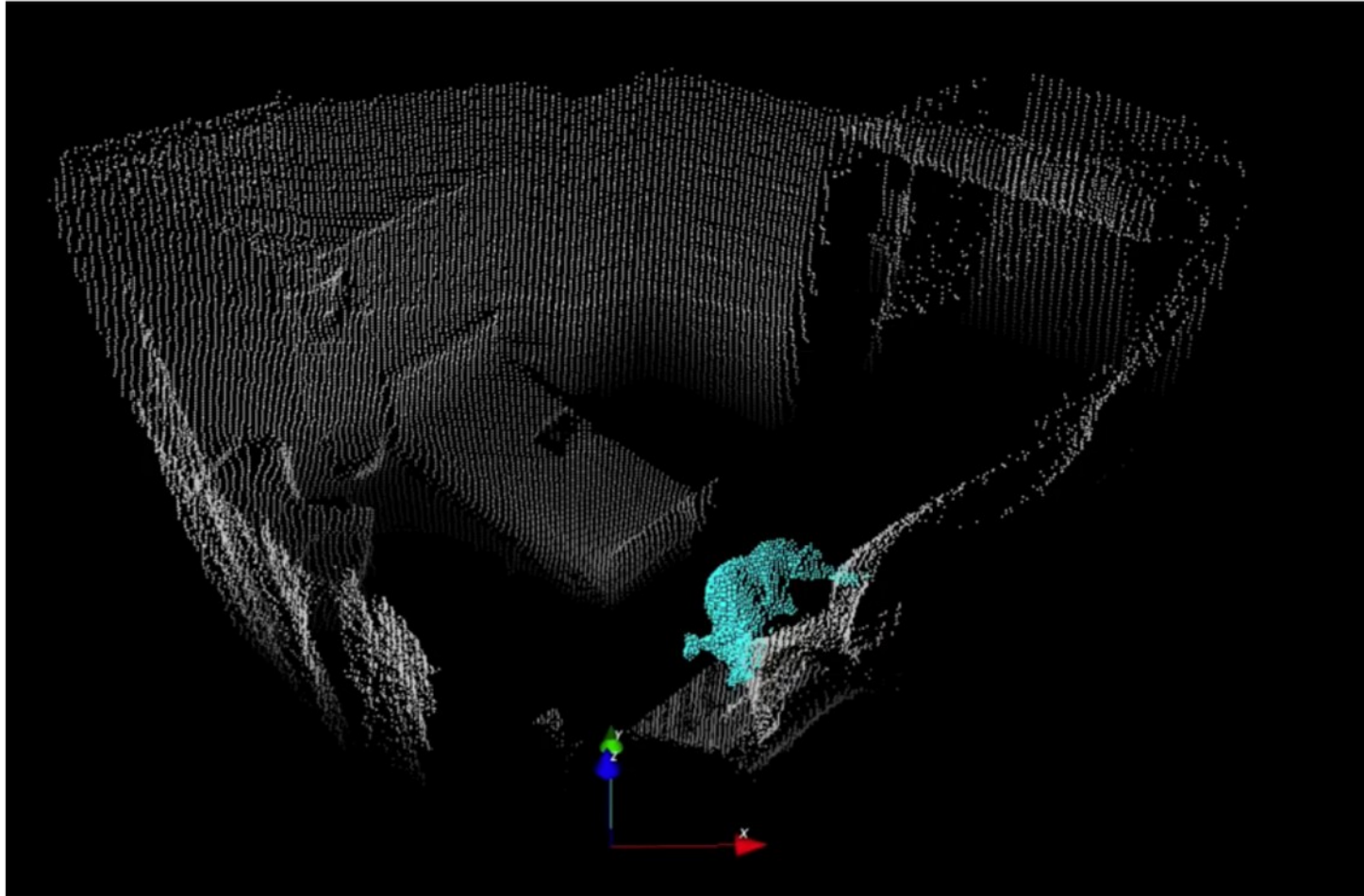
Source: ESPROS Photonics AG

# Point Cloud



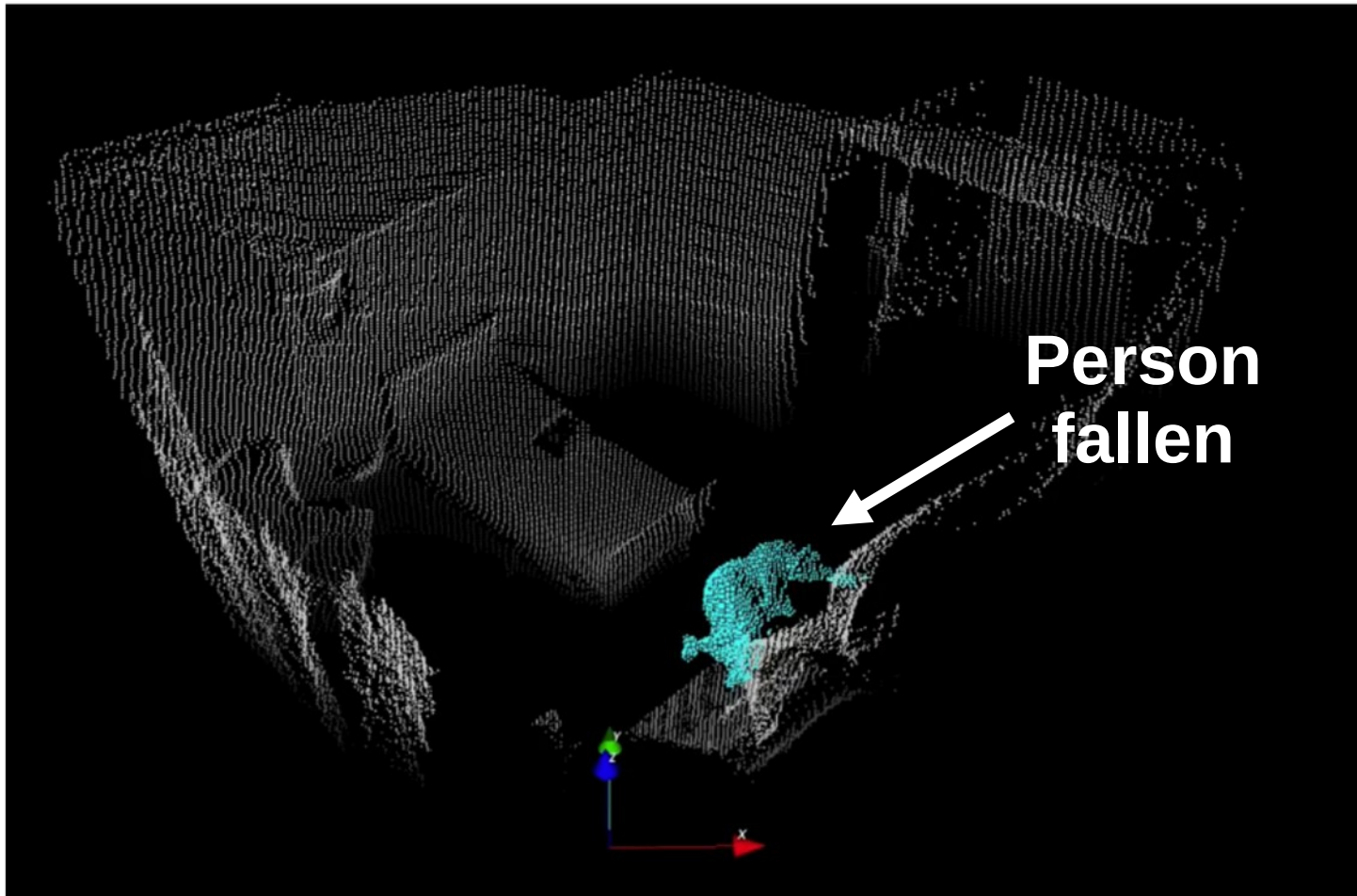
Source: ESPROS Photonics AG

# Object Discrimination and Classification



Source: Kaspard, 36, rue boulevard du souverain, 1170 Bruxelles, Belgium

## Use case evaluation



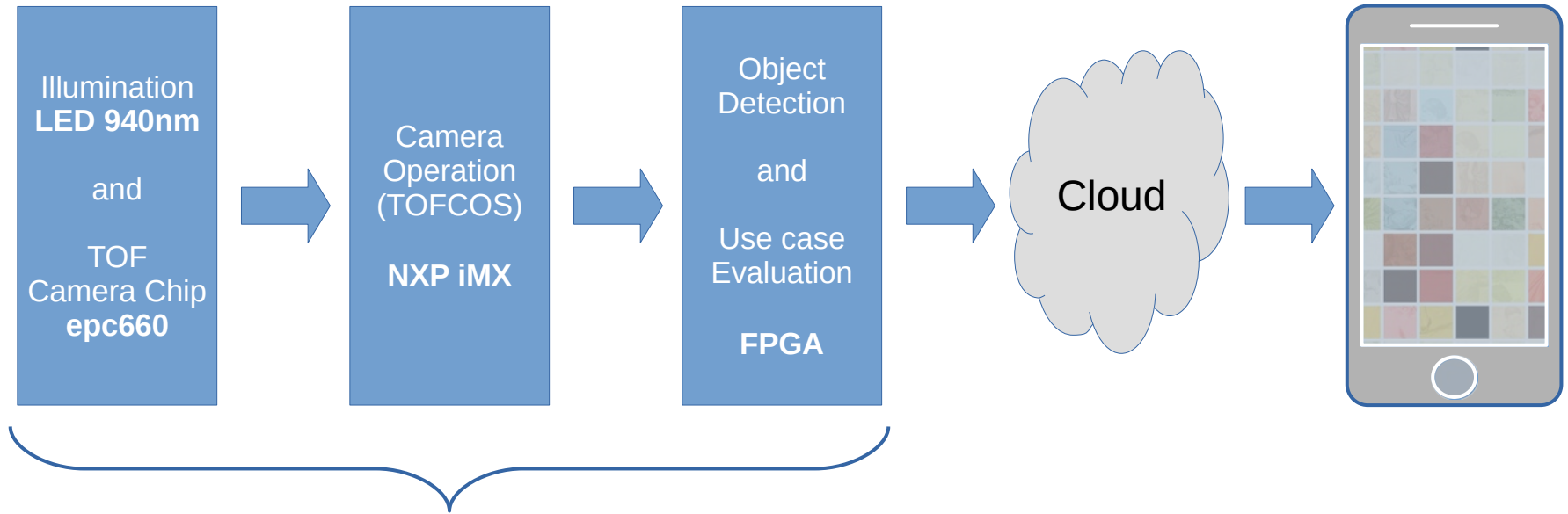
Source: Kaspard, 36, rue boulevard du souverain, 1170 Bruxelles, Belgium

## It's all done with this



Source: Kaspard, 36, rue boulevard du souverain, 1170 Bruxelles, Belgium

# It's all done with this



## Implementation Details

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- 3D camera TOFcam-660 from ESPROS
- Use case evaluation on XILINX SOM board (FPGA)
- Invisible NIR 940 nm LED
- PoE / Ethernet or WiFi to cloud
- Low power, no cooling fan
- App on smartphone or PC
  
- Most important: **Privacy of residents ensured!**

# Thank you!

<p><b>epc 611</b></p> <p>TOF range finder chip</p> <ul style="list-style-type: none"> <li>15m range / low accuracy</li> <li>4mm module / 1 channel</li> <li>low power / low cost</li> </ul> <p>Check it out!</p>	<p><b>epc 611</b></p> <p>TOF range finder chip</p> <ul style="list-style-type: none"> <li>8m range</li> <li>cm accuracy</li> <li>low power / low cost</li> </ul> <p>Check it out!</p>	<p><b>epc 611</b></p> <p>TOF range finder chip</p> <ul style="list-style-type: none"> <li>long range</li> <li>cm accuracy</li> <li>low power / low cost</li> </ul> <p>Check it out!</p>	<p><b>epc 611</b></p> <p>TOF range finder chip</p> <p>SLAH!</p> <ul style="list-style-type: none"> <li>15m range / low accuracy</li> <li>4mm module / 1 channel</li> <li>low power / low cost</li> </ul> <p>Check it out!</p>	<p><b>epc 611</b></p> <p>TOF range finder chip</p> <ul style="list-style-type: none"> <li>up to 15m range</li> <li>cm accuracy</li> <li>4mm module / 1 channel</li> <li>low power / low cost</li> </ul> <p>Check it out!</p>	<p><b>epc 611</b></p> <p>Touch-less Button</p>	<p><b>epc 611</b></p> <p>TOF range finder chip</p> <ul style="list-style-type: none"> <li>30 TOF range-finder</li> <li>10m range</li> </ul>	<p><b>epc 611</b></p> <p>3D TOF touch-less button</p>
<p><b>epc 635</b></p> <p>TOF camera chip</p> <ul style="list-style-type: none"> <li>15m x 6m pixel</li> <li>low power</li> <li>low cost</li> </ul> <p>Check it out!</p>	<p><b>epc 635</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>15m x 6m pixel</li> <li>door protection</li> <li>low power</li> <li>low cost</li> <li>easy to implement</li> </ul> <p>Check it out!</p>	<p><b>epc 635</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>Start/stop</li> <li>Direction of beam</li> <li>Area of interest</li> <li>presentation</li> </ul>	<p><b>epc 635</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>SLAH!</li> <li>direction of beam</li> <li>Area of interest</li> </ul>	<p><b>epc 635</b></p> <p>TOF camera chip</p> <ul style="list-style-type: none"> <li>10m x 6m pixel</li> <li>15m range</li> <li>low cost</li> </ul> <p>Check it out!</p>	<p><b>epc 635</b></p> <p>3D TOF camera</p> <ul style="list-style-type: none"> <li>15m x 6m pixel</li> <li>15m range</li> <li>30 frames per second</li> </ul>	<p><b>epc 635</b></p> <p>3D TOF camera</p> <ul style="list-style-type: none"> <li>15m x 6m pixel</li> <li>15m range</li> <li>30 frames per second</li> <li>data opening</li> <li>flexible direction</li> <li>digital zooming</li> </ul>	<p><b>epc 611</b></p> <p>TOF camera chip</p> <p>Cliff</p>
<p><b>epc 660</b></p> <p>TOF camera chip</p> <ul style="list-style-type: none"> <li>15m x 6m pixel</li> <li>low power</li> <li>low cost</li> </ul> <p>Check it out!</p>	<p><b>epc 660</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>15m x 6m pixel</li> <li>low power</li> <li>low cost</li> </ul> <p>Check it out!</p>	<p><b>epc 660</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>up to 50m</li> <li>0.2m x 0.2m pixel</li> </ul>	<p><b>epc 660</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>Cabin monitoring</li> </ul>	<p><b>epc 660</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>Object detection &amp; classification</li> <li>0.2m x 0.2m pixel</li> <li>up to 50m</li> </ul> <p>Check it out!</p>	<p><b>epc 660</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>3D TOF camera</li> <li>0.2m x 0.2m pixel</li> <li>0.1m range</li> </ul>	<p><b>TOF cam 660</b></p> <p>TOF camera</p>	<p><b>epc 635</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>15m range</li> <li>Object detection</li> <li>SLAH!</li> </ul>
<p><b>epc 901</b></p> <p>TOF camera chip</p> <ul style="list-style-type: none"> <li>1024 pixel / 7.5 x 120µm</li> <li>50,000 frames / s</li> </ul> <p>Check it out!</p>	<p><b>epc 901</b></p> <p>TOF camera chip</p> <ul style="list-style-type: none"> <li>Line imager</li> <li>1024 pixel</li> <li>0.15µm res.</li> <li>50,000 frames/s</li> </ul> <p>Check it out!</p>	<p><b>epc 901</b></p> <p>TOF camera chip</p> <ul style="list-style-type: none"> <li>Line imager</li> <li>1024 pixel / 7.5 x 120µm</li> <li>50,000 frames / second</li> </ul> <p>Check it out!</p>	<p><b>epc 901</b></p> <p>TOF camera chip</p> <ul style="list-style-type: none"> <li>Line imager chip</li> <li>1024 pixel / 7.5 x 120µm</li> <li>50,000 frames / second</li> </ul> <p>Check it out!</p>	<p><b>epc 901</b></p> <p>TOF camera chip</p> <ul style="list-style-type: none"> <li>Line imager</li> <li>1024 pixel</li> <li>0.15µm resolution</li> <li>check it out!</li> </ul>	<p><b>epc 901</b></p> <p>TOF camera chip</p> <ul style="list-style-type: none"> <li>Smart touch screen</li> <li>Multi touch</li> <li>high resolution</li> <li>proximity detection</li> </ul>	<p><b>epc 660</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>3D TOF camera</li> <li>15m x 6m pixel</li> <li>15m range</li> </ul>	<p><b>epc 660</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>15m x 6m pixel</li> <li>15m range</li> </ul>
<p><b>epc 860</b></p> <p>TOF camera chip</p> <ul style="list-style-type: none"> <li>LiDAR imager</li> <li>30m pixel vertical</li> <li>20,000 lines / second</li> </ul>	<p><b>TOF cam - 660</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>30m x 20m pixel</li> <li>10 fps</li> </ul>	<p><b>TOF cam - 635</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>15m x 6m pixel</li> <li>10 fps</li> <li>Collision avoidance</li> </ul>	<p><b>epc 660 NFL</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>15m</li> <li>high brightness</li> <li>10 fps</li> <li>30mm res. @ 1m</li> </ul>	<p><b>TOF cam - 635</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>15m x 6m pixel</li> <li>high accuracy</li> <li>10 fps</li> <li>collision avoidance</li> </ul>	<p><b>epc 138 + epc 200</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>Miniature &amp; amplifier</li> <li>robust substrate</li> <li>extremely cost effective</li> <li>extremely powerful!</li> </ul>	<p><b>TOF cam - 635</b></p> <p>TOF camera</p> <ul style="list-style-type: none"> <li>15m x 6m pixel</li> <li>high bright &amp; high accuracy</li> </ul>	