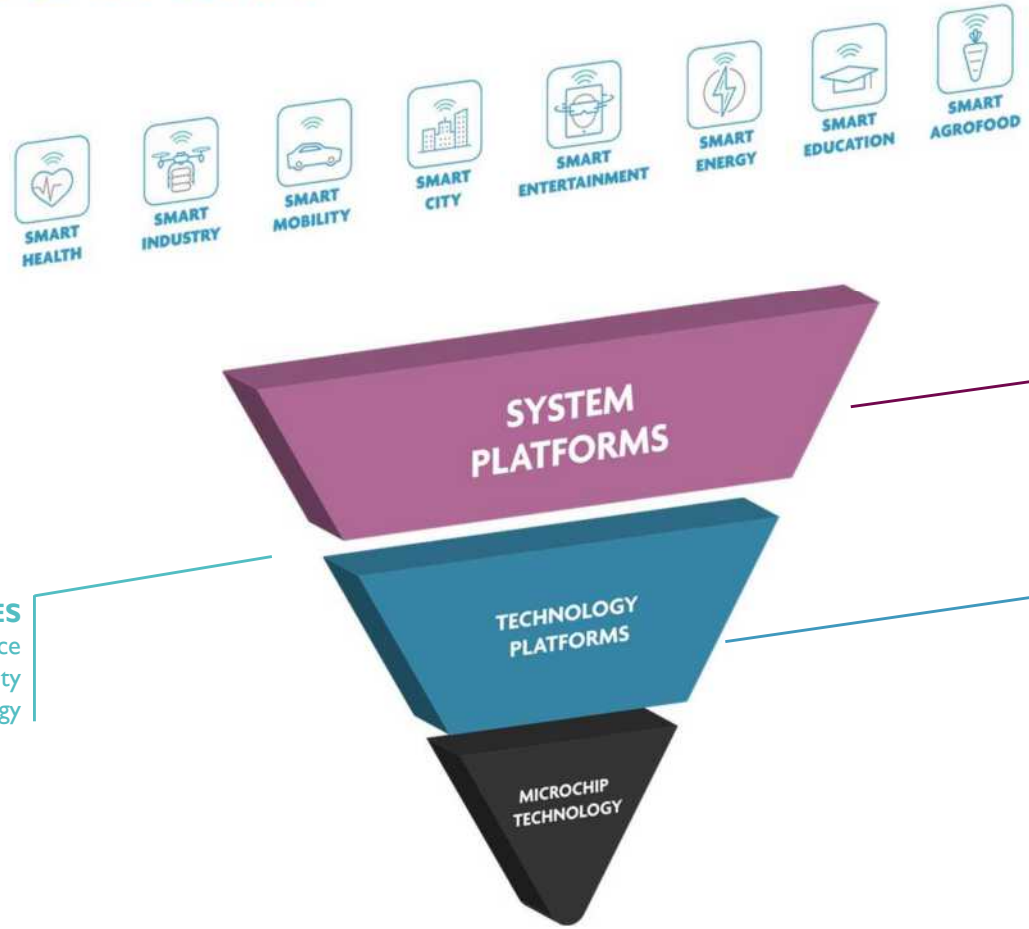
IMEC MULTIVIEW IMAGING SOLUTIONS

IMEC'S MISSION

- Imec is the world-leading R&D and innovation hub in nanoelectronics and digital technology.
- As a trusted partner for companies, start-ups and academia we bring together brilliant minds from all over the world in a creative and stimulating environment.
- By leveraging our world-class infrastructure and local and global ecosystem of diverse expert partners across a multitude of industries, we accelerate progress towards a connected, sustainable future


USA
SAN FRANCISCO
USA
ORLANDO
BELGIUM - HQ
LEUVEN
THE NETHERLANDS
EINDHOVEN
INDIA
BANGALORE
CHINA
SHANGHAI
JAPAN
OSAKA
JAPAN
TOKYO
TAIWAN
HSINCHU

INNOVATION PLATFORM



SYSTEM PLATFORMS
Neuromorphic computing
Beamforming platform
DNA sequencing
Nanofluidics processor
Cellsorter
RF technologies for 5G
Wireless sensor hub
Quantum computing
Lens free imaging
Hyperspectral imaging
Solid-state batteries
Solar cell systems
…

DIGITAL TECHNOLOGIES
Artificial intelligence
Privacy / cybersecurity
5G network technology

TECHNOLOGY PLATFORMS
Logic CMOS
Memory
3D heterogeneous integration
Photonics
MEMS & microfluidics
Sensor platform
Flexible technologies

WHAT WE OFFER

R&D
COLLABORATION

INNOVATION
SERVICES

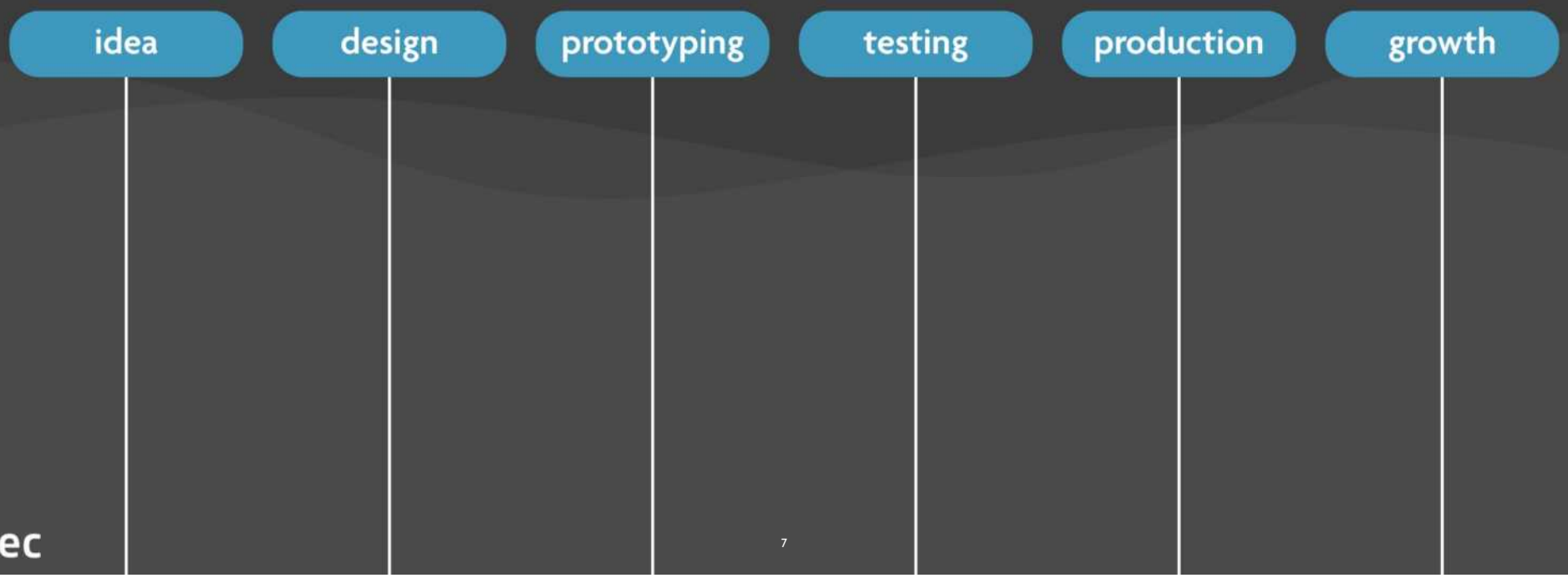
VENTURING
STARTUPS & FUNDS

IMEC INNOVATION SERVICES AND SOLUTIONS

Derisking and accelerating nanoelectronics and digital innovation

imec

SUPPORTING COMPANIES' INNOVATION LIFECYCLE



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FULL TURN-KEY
PRODUCT DEVELOPMENT SERVICES

ENABLING ENTREPRENEURS TO FAST-TRACK MARKET ENTRY AND SCALE-UP

Smart Vision and Imaging

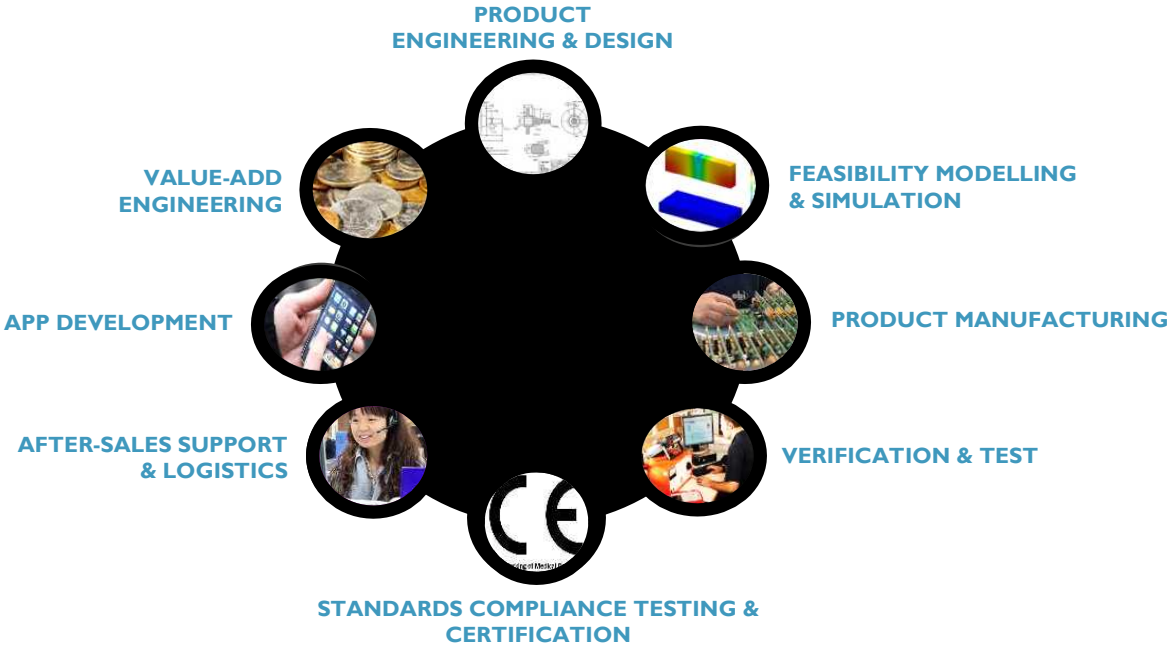
- Camera system design
- Algorithm and processing implementation

Smart devices and IoT

- Smart Wearable devices
- Medical devices

Materials and Interconnects

- Flexible electronics
- Textile integration
- Micro-LED



SMART
MOBILITY

SMART
HEALTH

SMART
INDUSTRIES

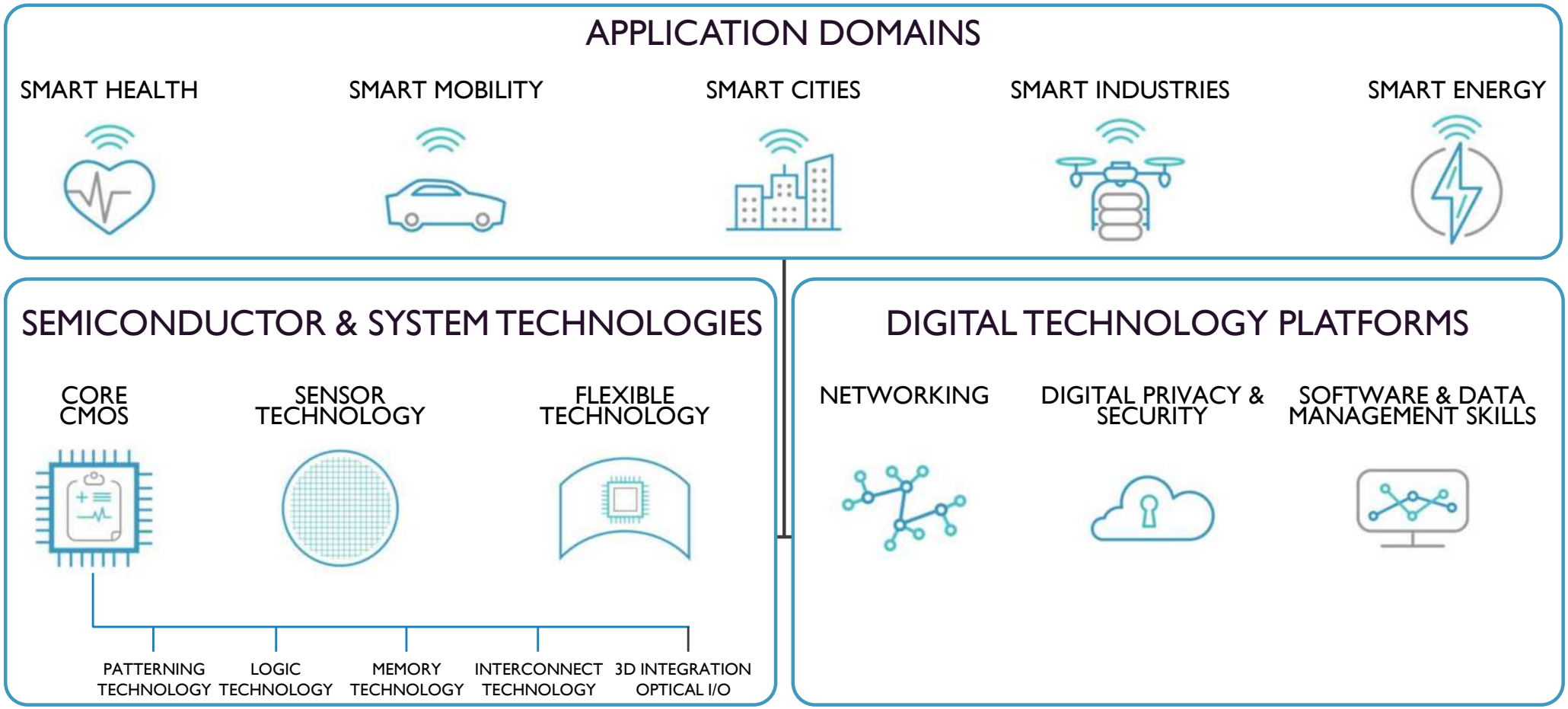
SMART
CITIES

SMART
ENERGY

SMART
EDUCATION

SMART
INFOTAINMENT

SMART
AGROFOOD


APPLICATION DOMAINS
SMART HEALTH
SMART MOBILITY
SMART CITIES
SMART INDUSTRIES
SMART ENERGY
SEMICONDUCTOR & SYSTEM TECHNOLOGIES
CORE CMOS
SENSOR TECHNOLOGY
FLEXIBLE TECHNOLOGY
PATTERNING TECHNOLOGY
LOGIC TECHNOLOGY
MEMORY TECHNOLOGY
INTERCONNECT TECHNOLOGY
3D INTEGRATION OPTICAL I/O
DIGITAL TECHNOLOGY PLATFORMS
NETWORKING
DIGITAL PRIVACY & SECURITY
SOFTWARE & DATA MANAGEMENT SKILLS

IMEC VISION AND IMAGING MULTIVIEW

IMEC SMART VISION AND IMAGING

EXPERIENCE IN IMAGING PROCESSING

- Multiview Vision –
  - 15+ imec patents (USA, EU, Taiwan)
  - Experience in GPU, **FPGA**, processor based algorithm since 2007 (Belgium), and 2009 (Taiwan)
  - Flexible to adapt broad applications
  - Custom combination of image/optical sensors (IR, RGB, Multi-spectral, LWIR, Radar …)

- Engineering, Prototyping and Production
  - Strength of combining multiple vision sensing technologies together
  - Access to cutting-edge technology
  - From idea to mass-production

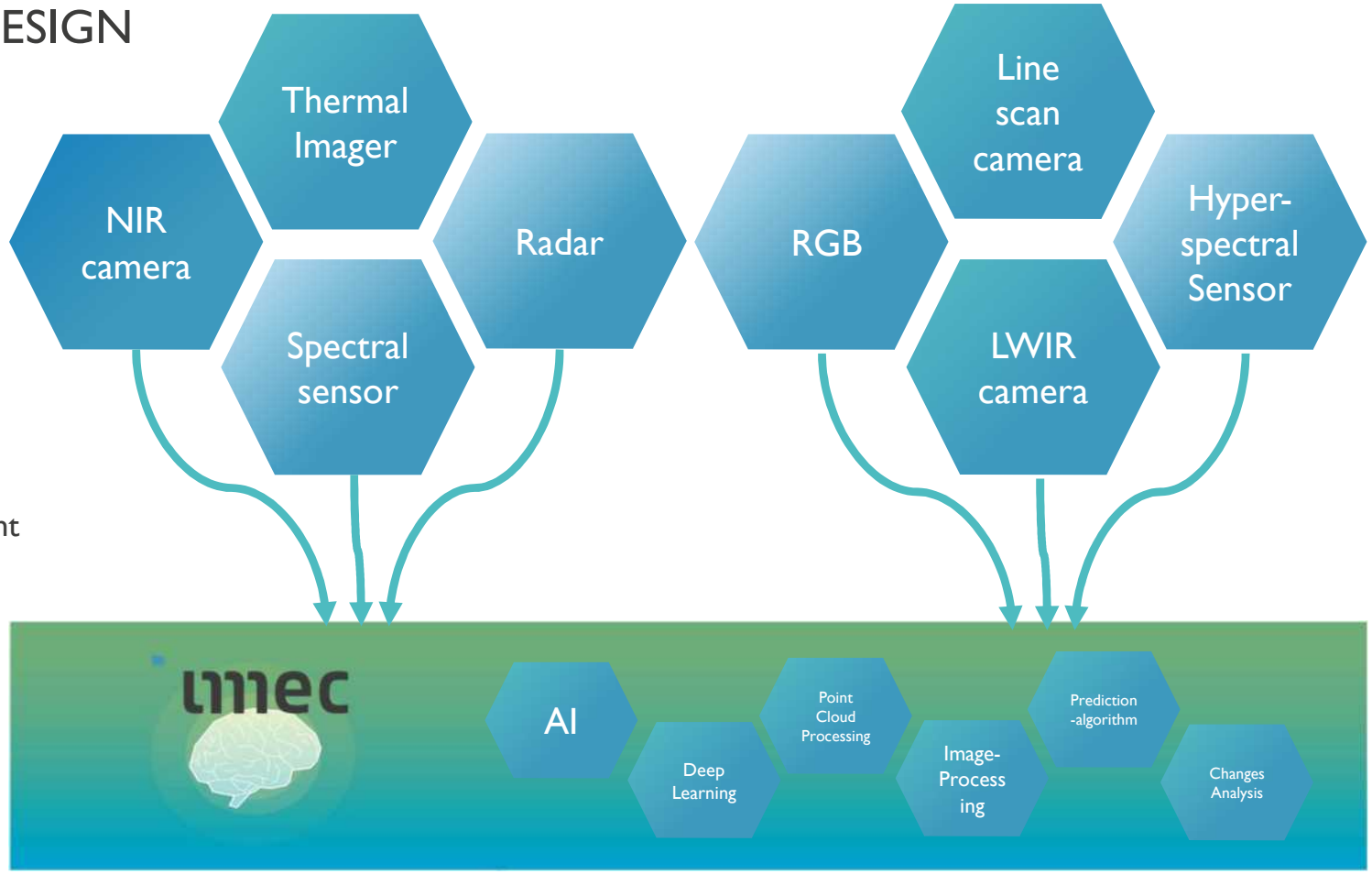
CUSTOMIZED SENSOR FUSION & ALGORITHM DEVELOPMENT

MODULAR DESIGN

Custom sensor fusion

Integration

Algorithm development



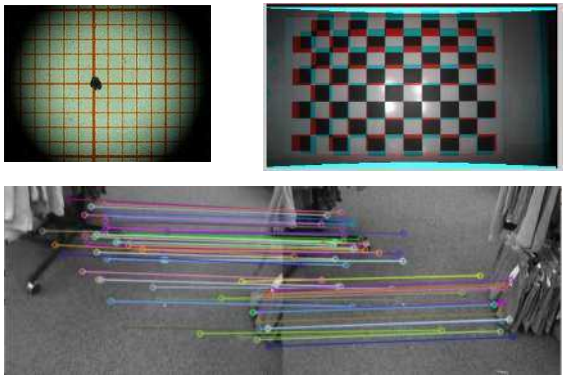
WHY MULTIVIEW ?

- Combine multiple imagers and optical sensors in one integrated system
  - Build to specification within one system
  - No performance limitations due to interface restrictions
  - Compact form factor and mechanical design
  - Multiview fusion
  - Algorithms
  - Tailor made software API

- Development of application specific algorithm
  - in-house expertise / IP
  - Experienced R&D team
  - Enabling ultra fast and low–latency data-processing.

- Offer full-fetched software SDK
  - Adaption of output format to customer needs
  - Linux drivers or other platforms

Integrated embedded system

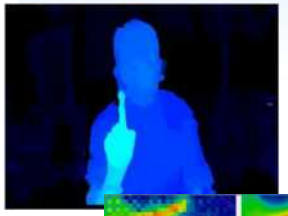


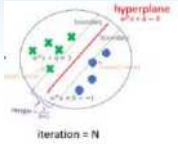
HW- accelerated ISP

IMEC MULTIVIEW IMAGING AND SENSING CAPABILITIES

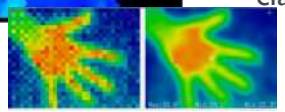
Algorithm development

Ultrafast stereo vision

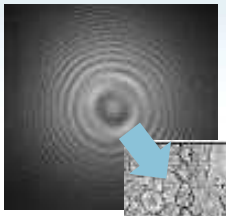




Spectral classification



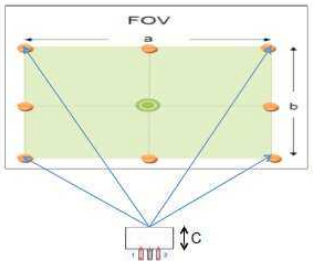
Thermal sensing

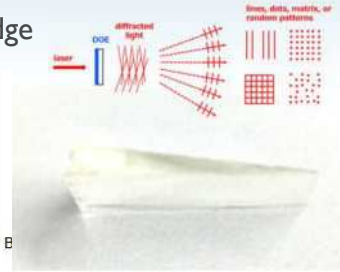


Holographic reconstruction

Optics & Lighting design and prototyping

Wedge



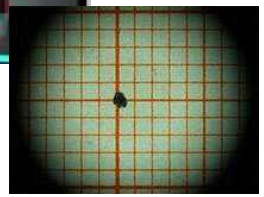


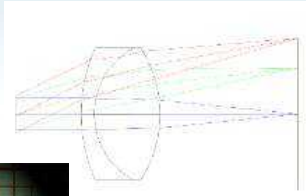
Laser/LED

Collimator

Calibration development

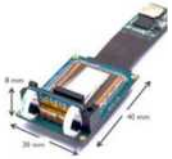
Rectification





Distortion & Vignetting compensation

System architect and build



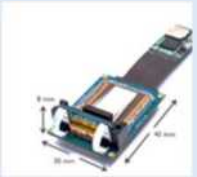
TYPES OF SYSTEMS WE BUILD

High-volume integration
Cost-effective

Imec Offering:
- Hardware design and integration
- Algorithm development
- Mechanical design
- Firmware/Software development
- System development

Examples:
- Spectral sensing module for liquid recognition
- Handheld thermal imaging
- ....





High performance
High resolution

Imec Offering:
- Hardware design and integration
- Algorithm development
- Mechanical design
- Firmware/Software development
- System development

Examples:
- High-resolution Industrial camera for bin-picking
- Custom Hyperspectral camera for forensic analysis
- ....

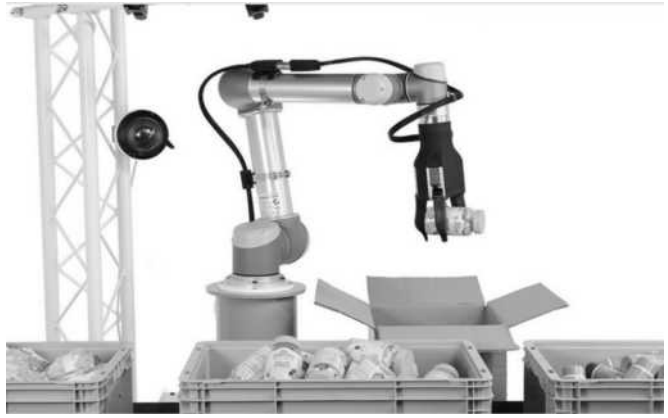

BROAD APPLICATION-FIELD

Robotic vision

- **High throughput**
- **3D complex scanning**
- **High dynamic range**
- **Arbitrary motion robot**
- **Dynamic trajectory**
- **High-precision**

Automatic guided vehicle

- **High frame rate**
- **3D surrounding volume scanning**
- **Long distance measurement**
- **Relative speed and acceleration**



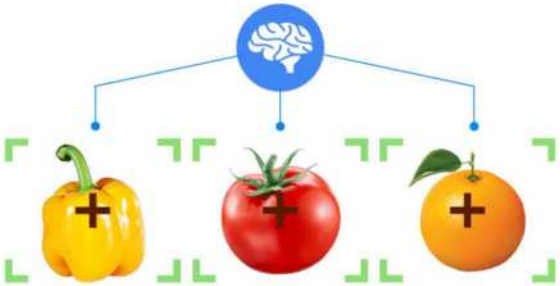
BROAD APPLICATION-FIELD

Smart Farming and Agriculture

- **Food quality**
- **3D complex scanning**
- **High dynamic range**
- **Spectral information**

Quality inspection

- **Freshness detection**
- **Classification**
- **Non-contact measurement**
- **Algorithm**



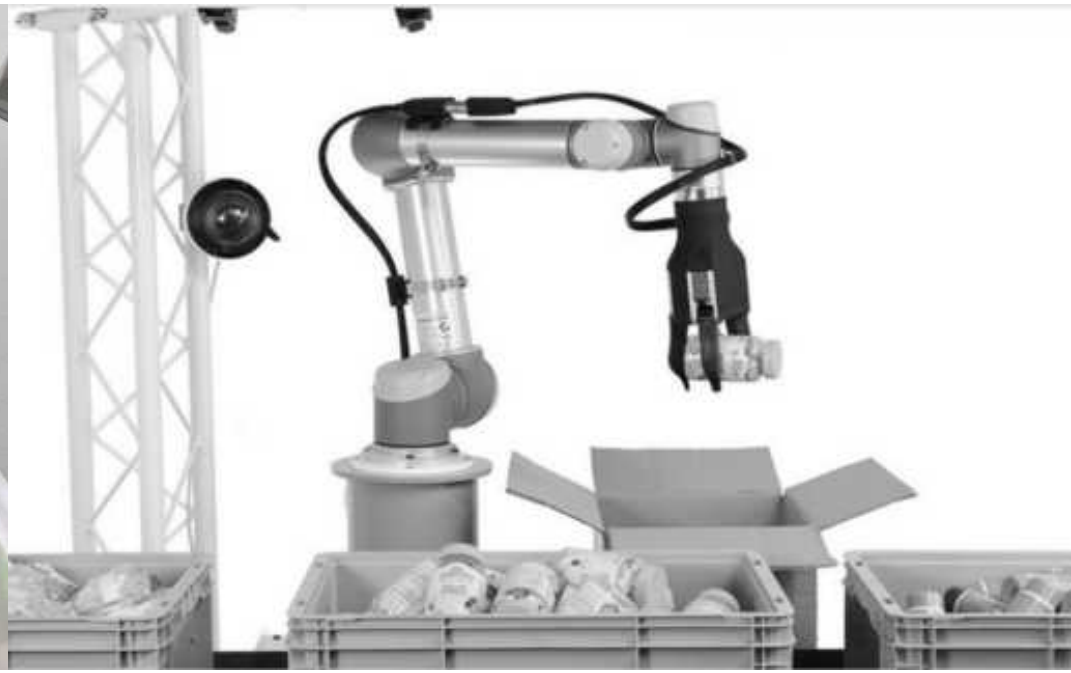
BROAD APPLICATION-FIELD

Smart Home

- **Household robots**
- **3D scanning**
- **Floor-type detection**
- **Spot detection**
- **Material analysis**
- **Freshness detection**
- **Water quality checking**
- **Personal green-house**
- **Pet-health**
- **Personal health**

CASE STUDY
INDUSTRIAL BIN PICKING

ROBOTIC BIN PICKING



Robots need eyes ! ... Good eyes !

AUTOMATION COMPANIES ENCOUNTER LIMITATIONS !

- Off-the-shelve camera's ...
  - Limited usage flexibility (for example USB 3.0 interface)
  - Limited optical flexibility (fixed optics)
  - Limited Integration (for example connect multiple camera's from different angles)
  - Limited Software flexibility (use of vendor specific tools)
  - Limited performance (Generic ←→ Use case specific)

WHAT PROBLEMS DO WE NEED TO SOLVE

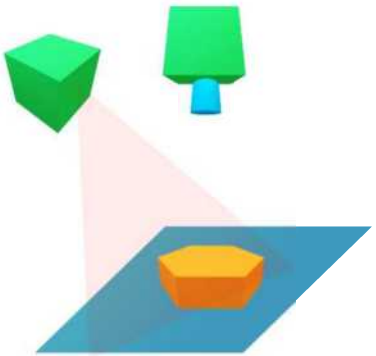
- Camera optimized in performance to your use case !
  (very small precise object , fast running assembly line , working range, ...)

- Your connection interface:
  USB, Ethernet, custom, ...

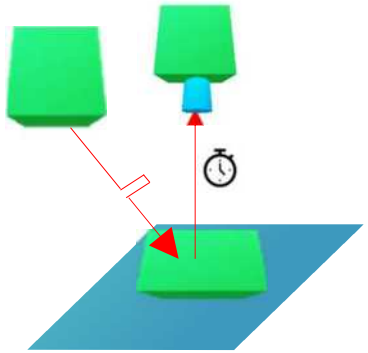
- Easy integration your ecosystem or legacy environment
  ROS-based, C#, Linux, Windows, Python, ...

- Camera optimized to your formfactor
  Weight, Length, Industrial Design, ...

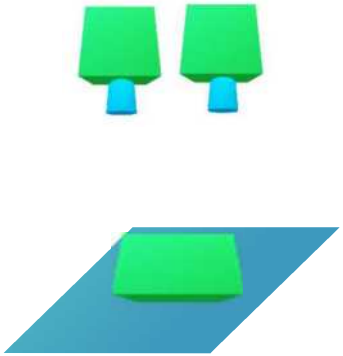
TECHNIQUES TO GET 3D INFORMATION



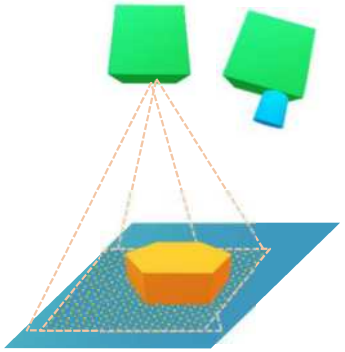
Laser Triangulation
Scanning , Best Z-resolution
Expensive and slow



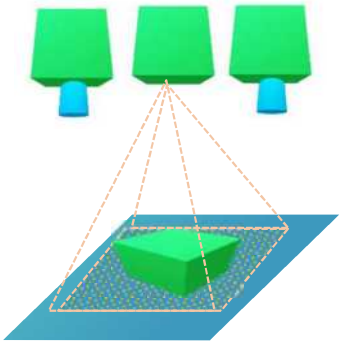
Time of flight (ToF)
Full image coverage, Z-resolution cm range
Fast and cheap



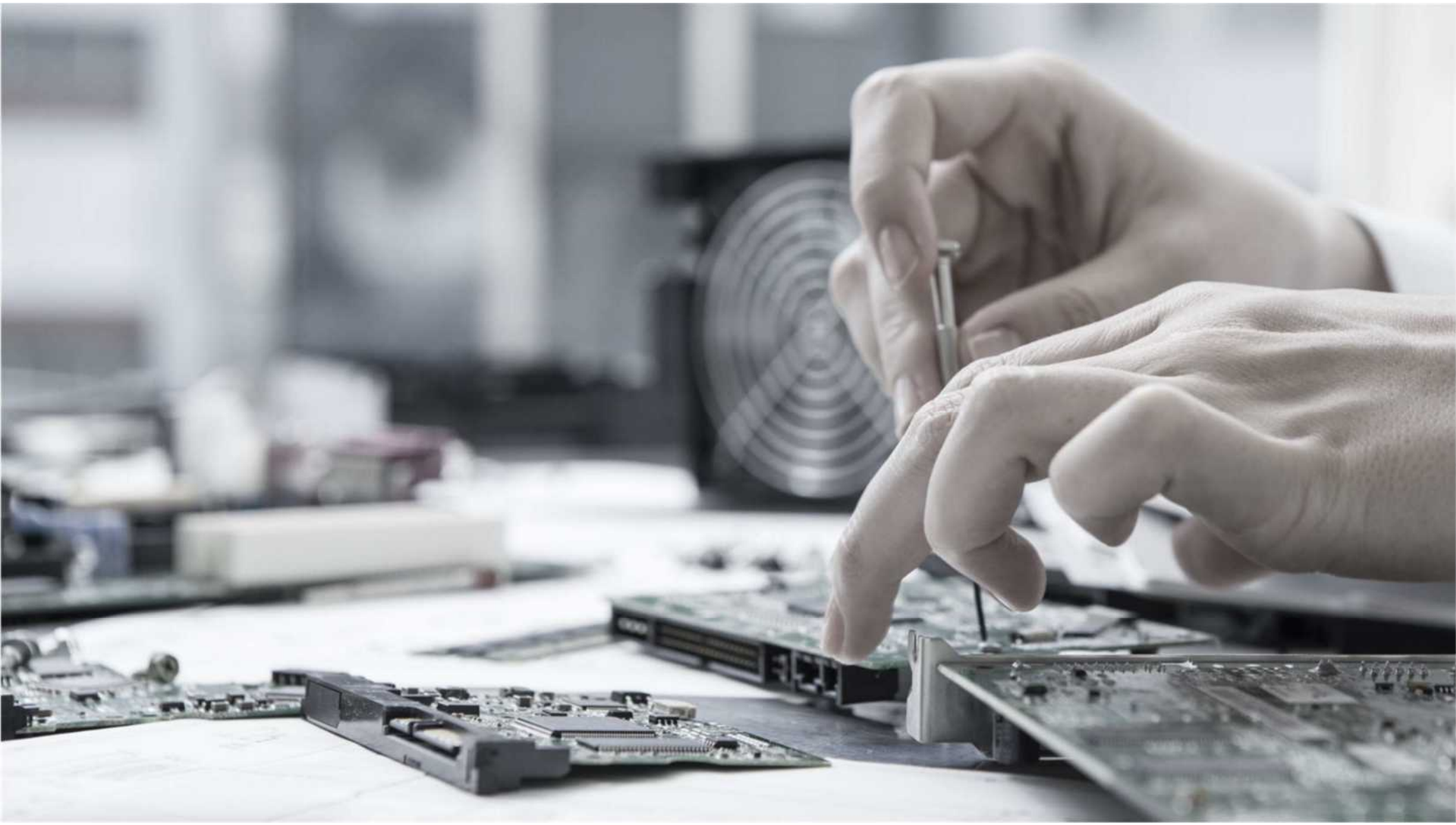
Passive stereovision
Full image coverage, Better Z-resolution
Needs computing power,
problems with homogenous surfaces



Structured light
Accurate
expensive

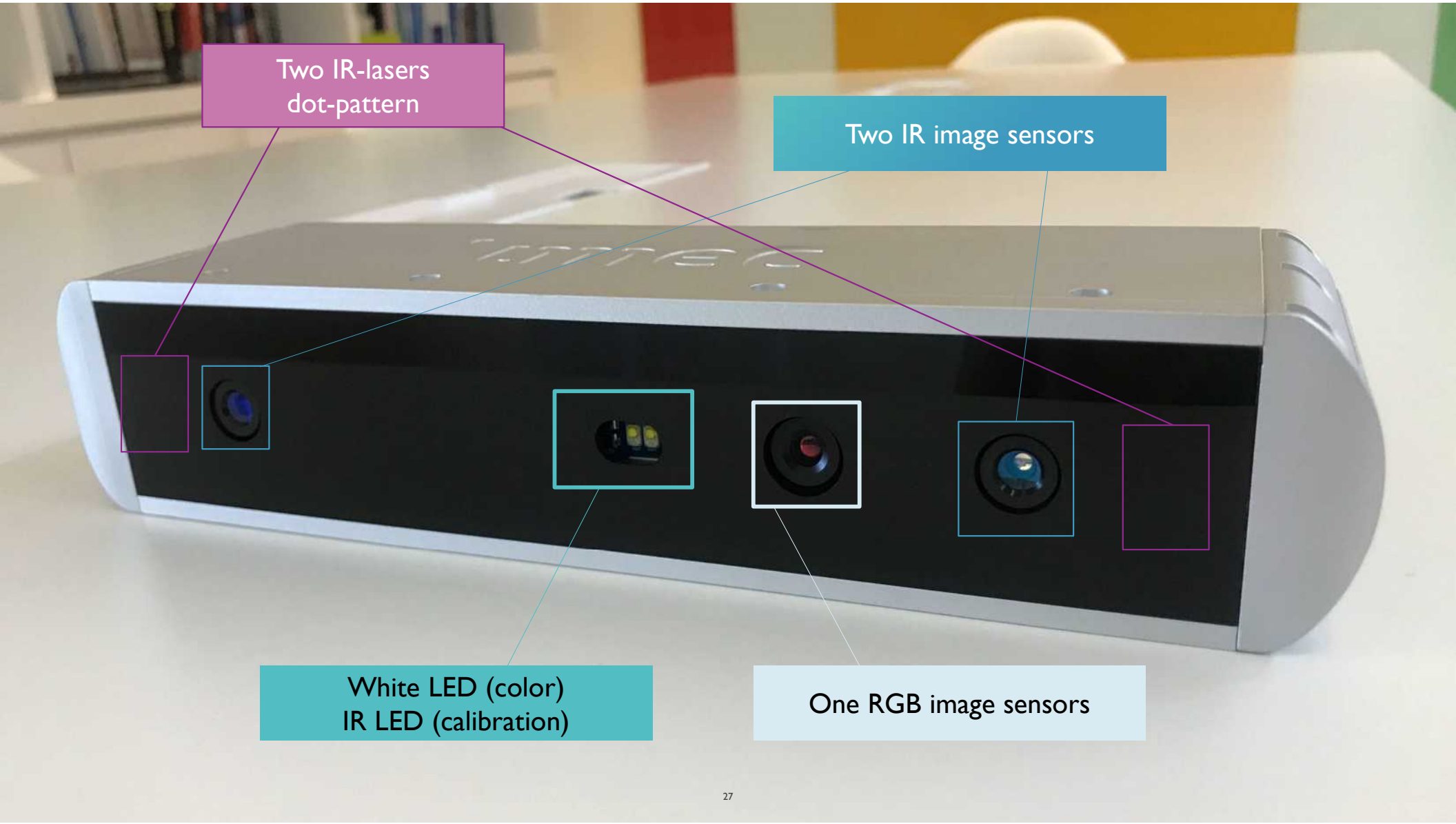


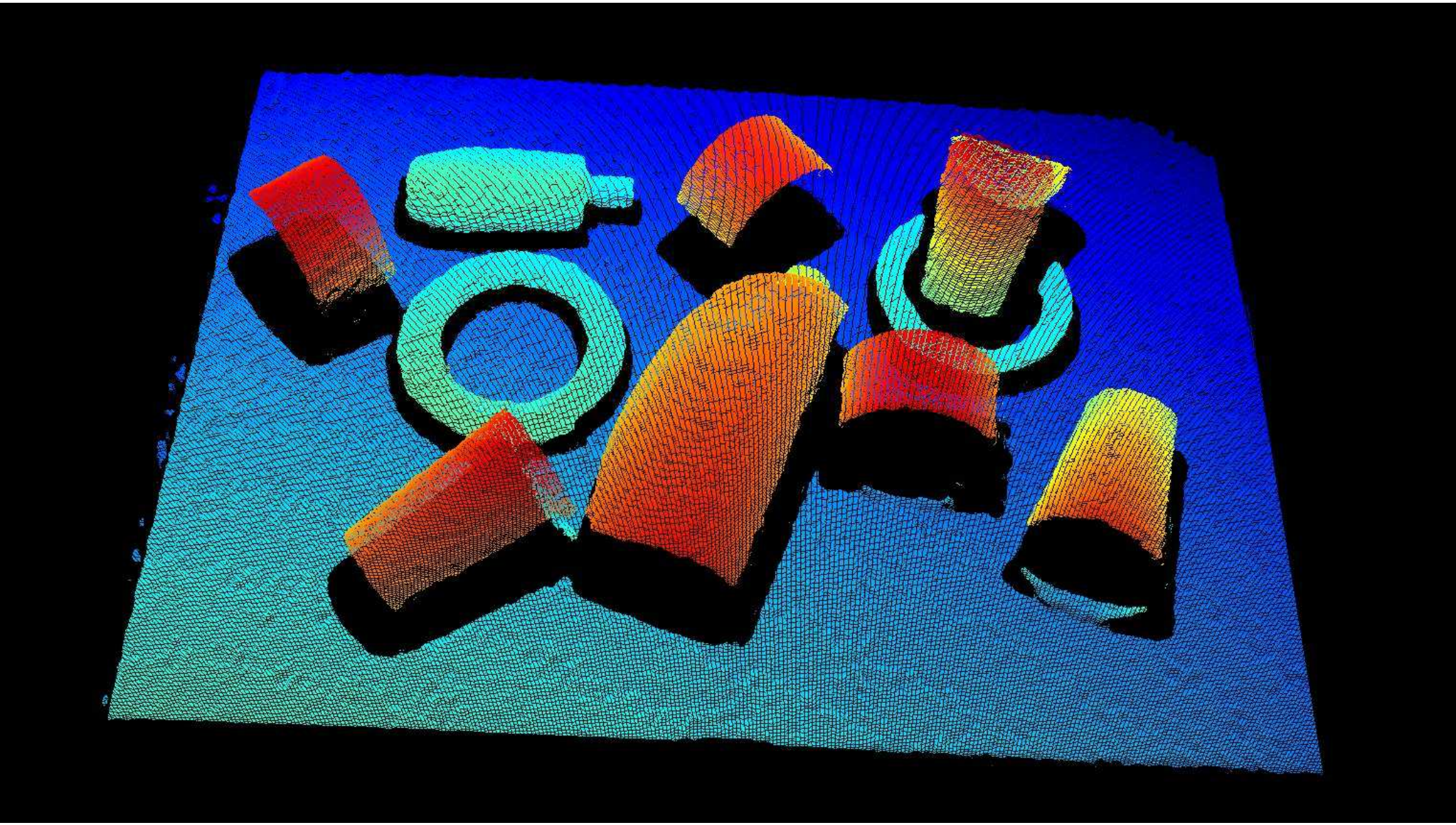
Active stereovision
No problems with homogenous surfaces



DEMO PLATFORM: INDUSTRIAL 3D-IMAGING

- Hardware Accelerated Processing(FPGA)
- High resolution 3D-scan (720p)
- High frame rate (90 - 120 fps)
- Precision measurement (sub-mm)
- High dynamic Range (HDR)
- Color PointCloud data output
- Near/middle scanning range
- GigE connection port
- Windows/Linux host
- Aluminum Fanless encasing


Two IR-lasers
dot-pattern
Two IR image sensors
White LED (color)
IR LED (calibration)
One RGB image sensors

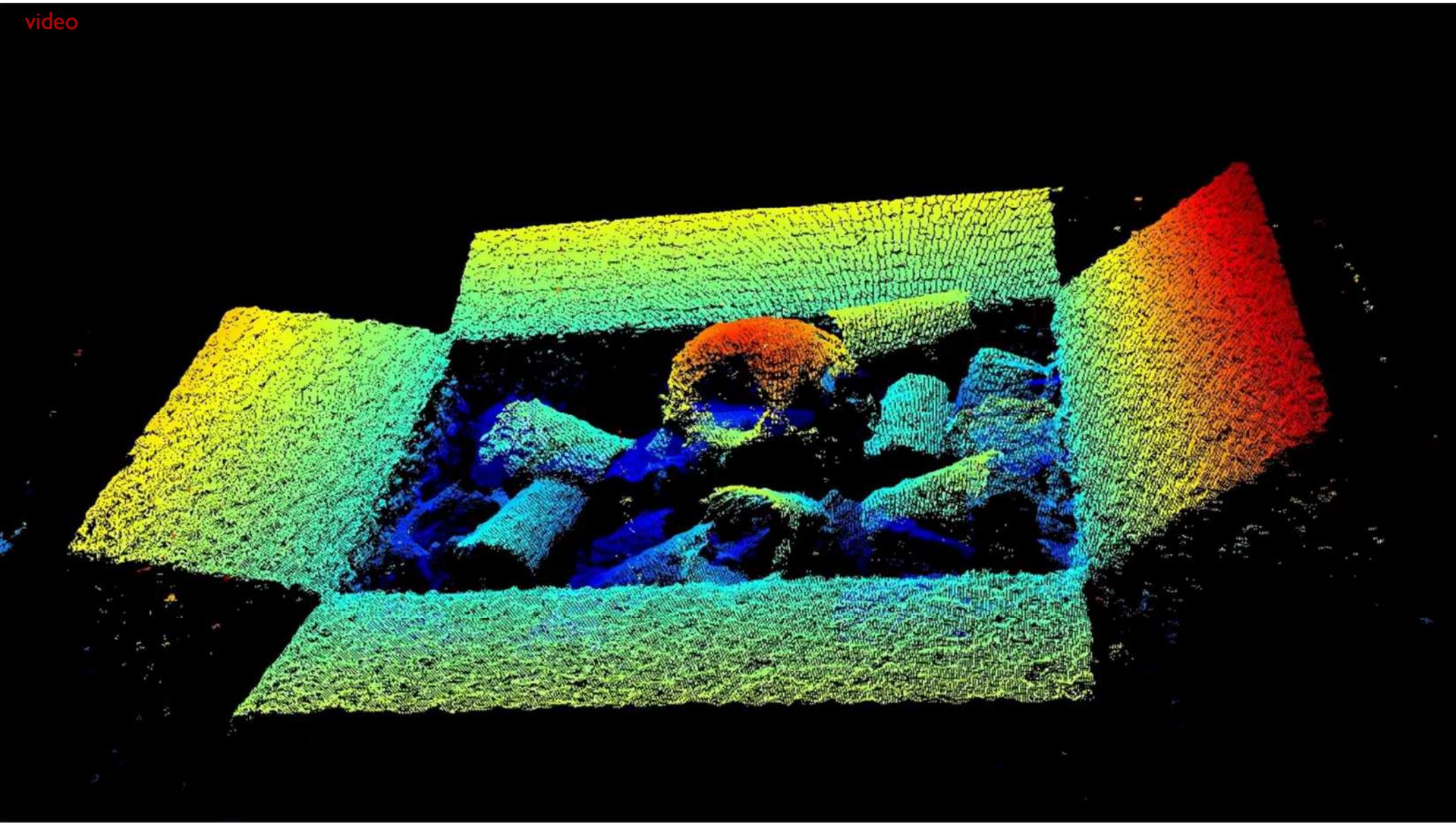



VISION

DEMO OBJECT BINNING FROM A BOX

- In this demo the camera is setup in top-down scanning.
- Objects are contained in the package box in a distance of 80cm from the camera.
- Objects include the paper cup, tape, Nylone packaging straps, etc..

video



CASE STUDY
AGRICULTURAL ROBOTICS

FRUIT PICKING ROBOT

WHAT IS SPECIAL ABOUT FRUIT

- Irregular shapes
  - Class A vs. Class B

3D-Vision

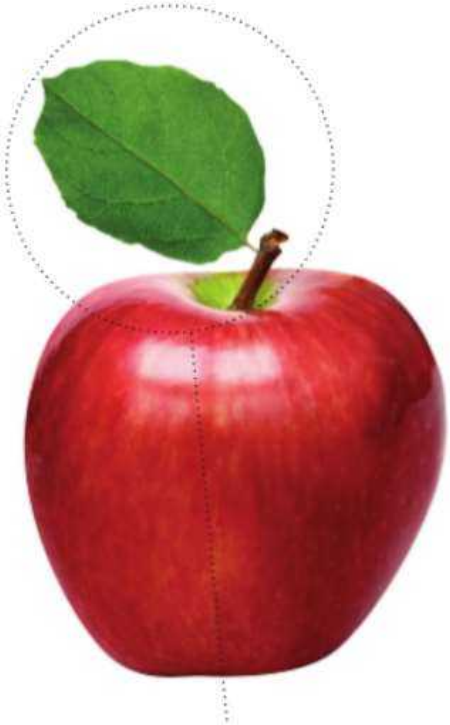
- Fruit ripeness is important
  - Don't pick to early, don't pick too late
- Fruit can have "defects"
  - Diseases , insects, missing pieces , ...

3D-Vision ?

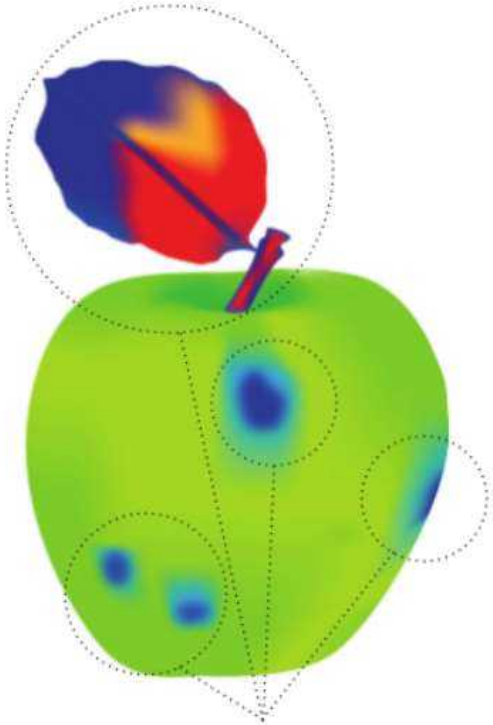
+

Hyperspectral Imaging !

MONOCHROME
imaging



COLOR
imaging

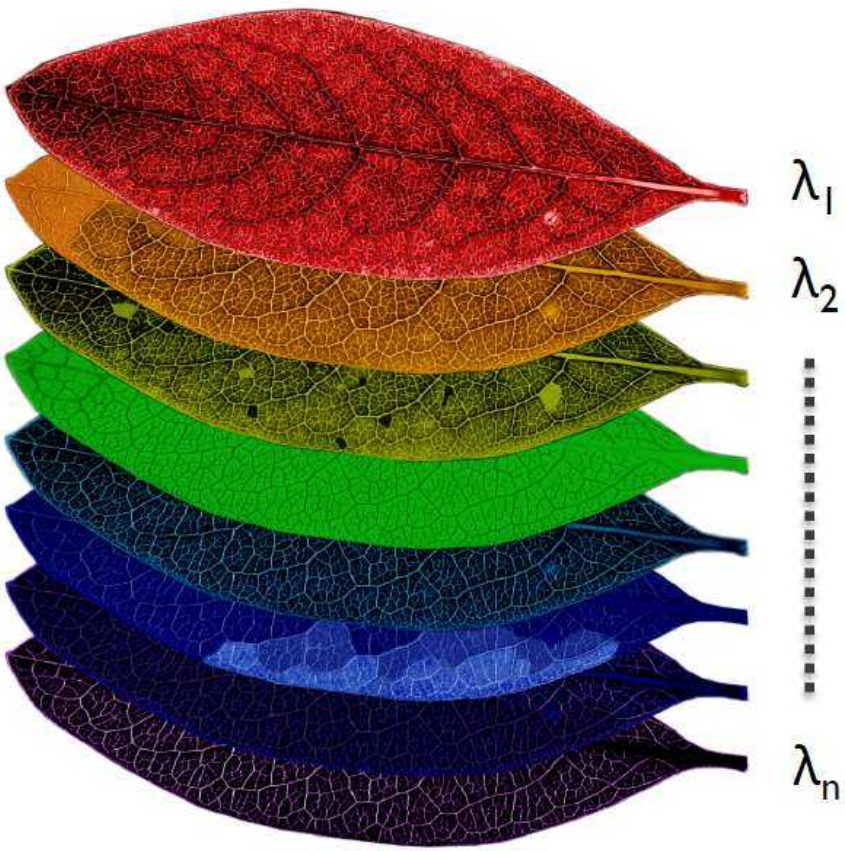


HYPERSPECTRAL
imaging

EVOLUTION OF MACHINE VISION

Courtesy of Perception Park

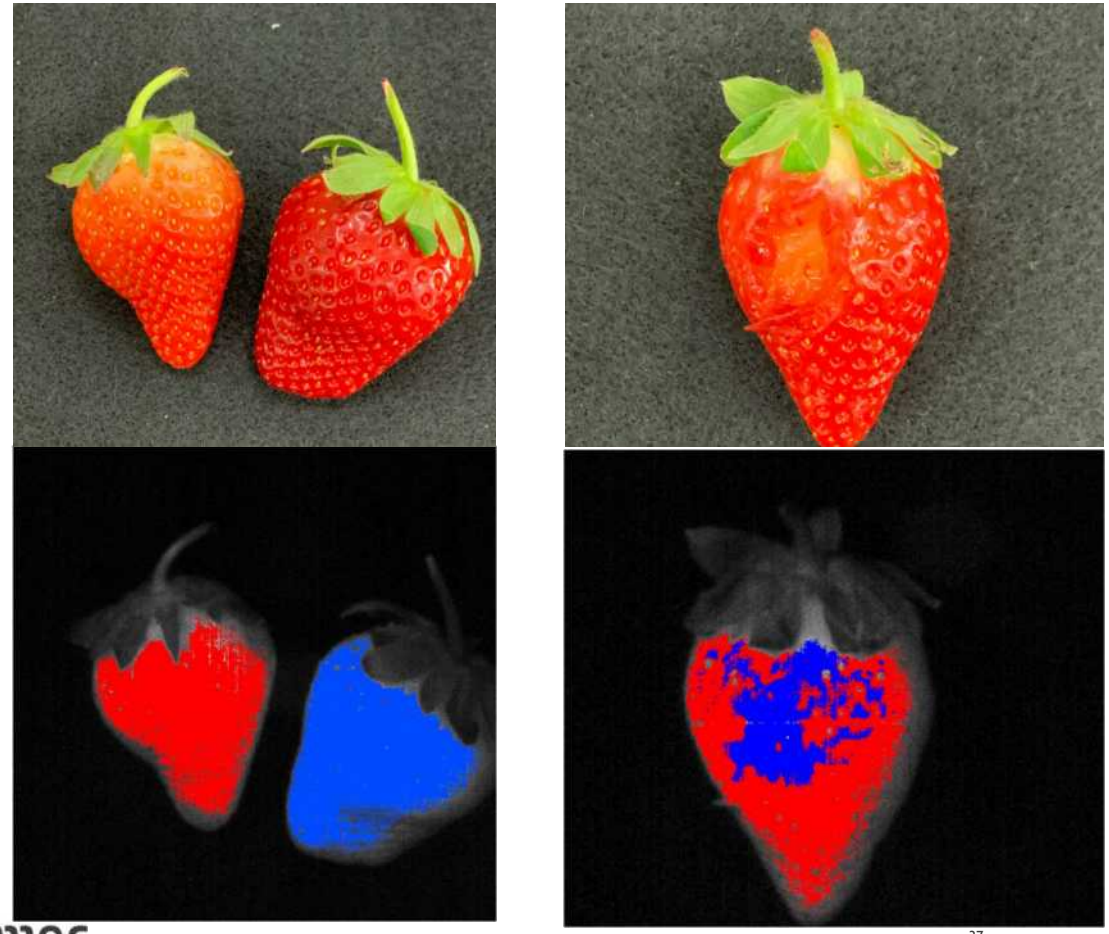
WHY DO WE NEED HYPERSPECTRAL IMAGING?

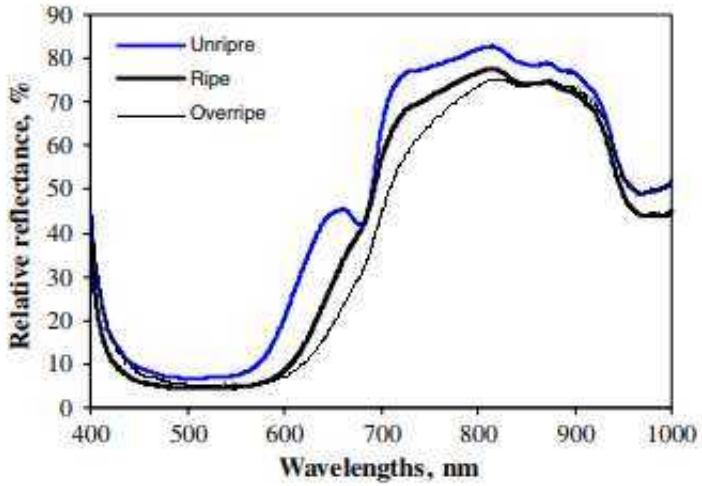


to improve vision
and discrimination power ...

... by using
spectral dimension of
objects being imaged

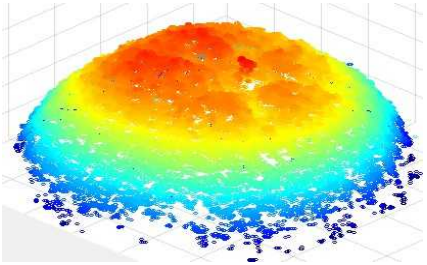
HYPERSPECTRAL IMAGING



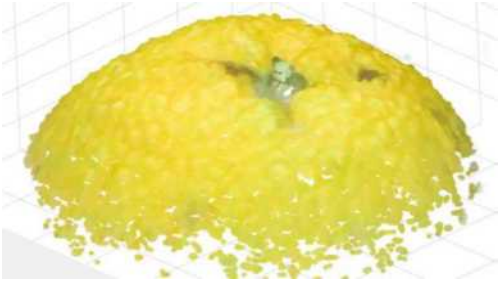


Hyperspectral imaging for **nondestructive determination** of **some quality attributes** for **strawberry** [2007].
ElMasry, **G**. **Wang**, **N**. **ElSayed**, A. **Ngadi**, **M**

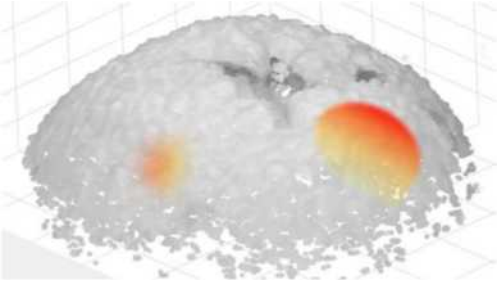
MULTIVIEW COMBO



3d – view of orange
for bin picking



Color remapping
for classification



Spectral info remapping
for detection of
decomposition stains

LWIR info mapping
To find fruit with too
high temperature

imec

CASE STUDY 3
FOOD AND BEVERAGE APPLIANCES

MULTIVIEW WITH SPECTRAL ANALYSIS

- Hyperspectral is so powerful ! Reveal the invisible !
  - Lab equipment, robotics, industrial quality control, ...
- How about consumer products ?
  - Higher volume
  - Cost-effective
  - High level of integration
  - .....

TYPES OF COFFEE SERVED IN ITALY

NOT ALL DRINKS ARE THE SAME

- Milk
  - Soy milk
  - Fat milk
  - Skim milk
  - ....
- Coffee
  - Dark Roast
  - Light
  - Medium

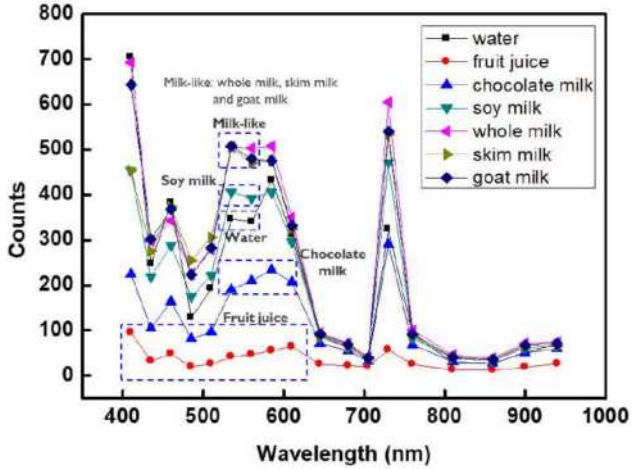
Different types of "raw material"
needs different type of processing

Can these pre-condition automatically be determined ?

HOW TO DETECT TYPE OF MILK

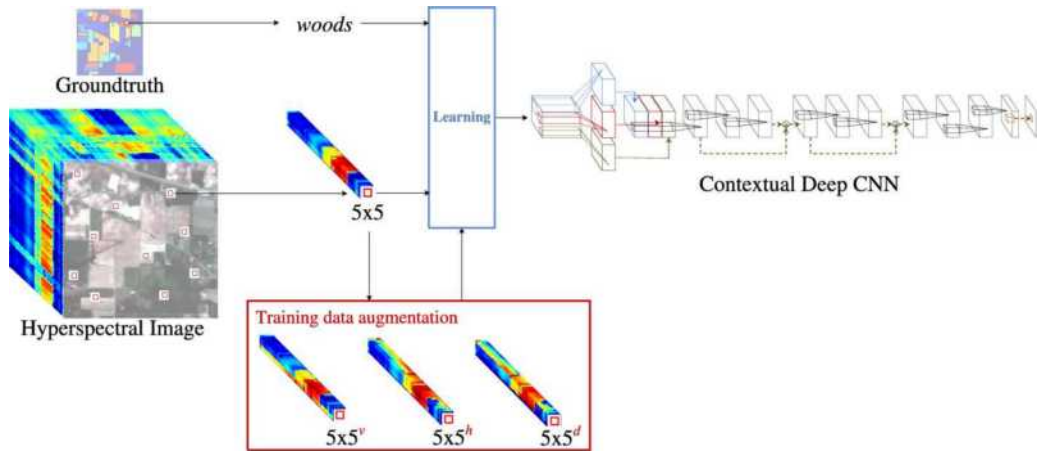
COST-EFFECTIVE SPECTRAL SENSING !

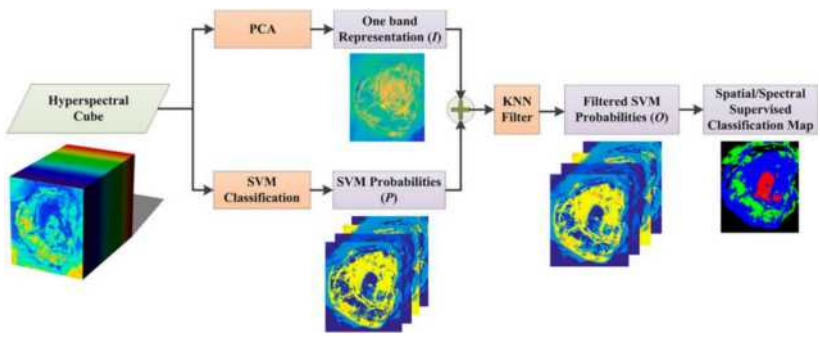
	Liquid type	Source	Experiment sample
Milk	Whole (fat: 3% ~ 3.8%)		
Milk	Semi-skimmed (fat: 0.5% ~ 1.5%)		
Soy Milk			



ON THE EDGE
MACHINE LEARNING AND AI

- Classification algorithms:
  - Naïve Bayes
  - SVM
  - K-nearest neighbor
  - Neural Networking
  - PCA
  - …





INTEGRATIONS

CASE STUDY:
SURVEILLANCE AND PEOPLE TRACKING

INDOOR TRACKING AND WAY FINDING

TRADITIONAL SURVEILLANCE

WHY DO WE NEED MULTIVIEW

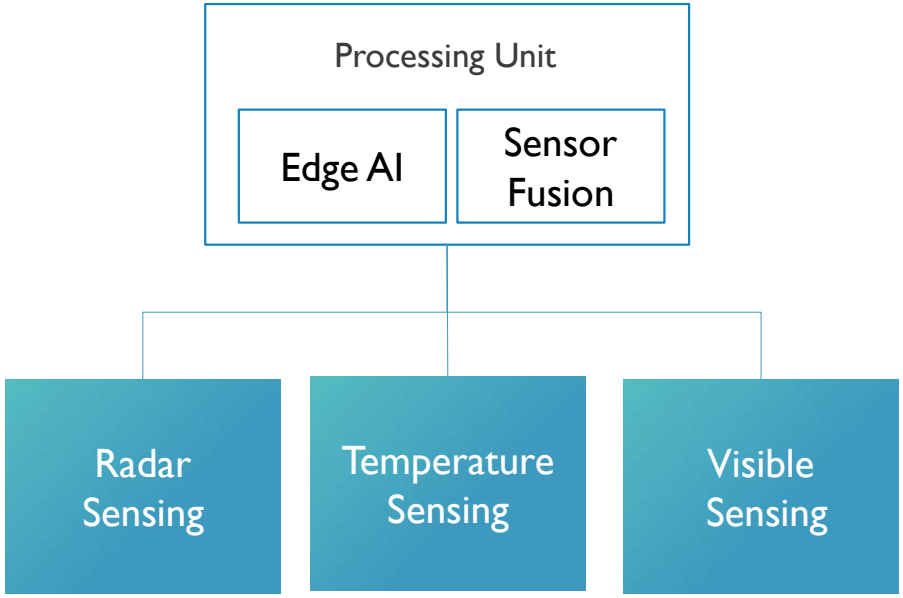
- Don't rely on humans ! Computers never get tired
- Limited parameters to track !

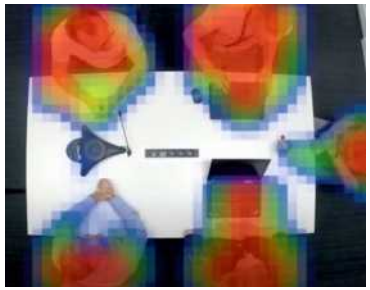
- Covid-19 changed the way of thinking. We need systems to:
  - Check body temperatures
  - Check if social distancing is respected
  - Count people (capacity problems in class rooms)
  - Check if facemask are worn where needed

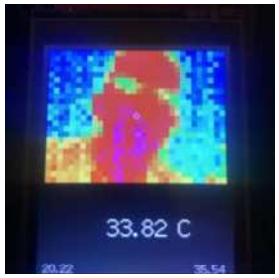
... Multiview !

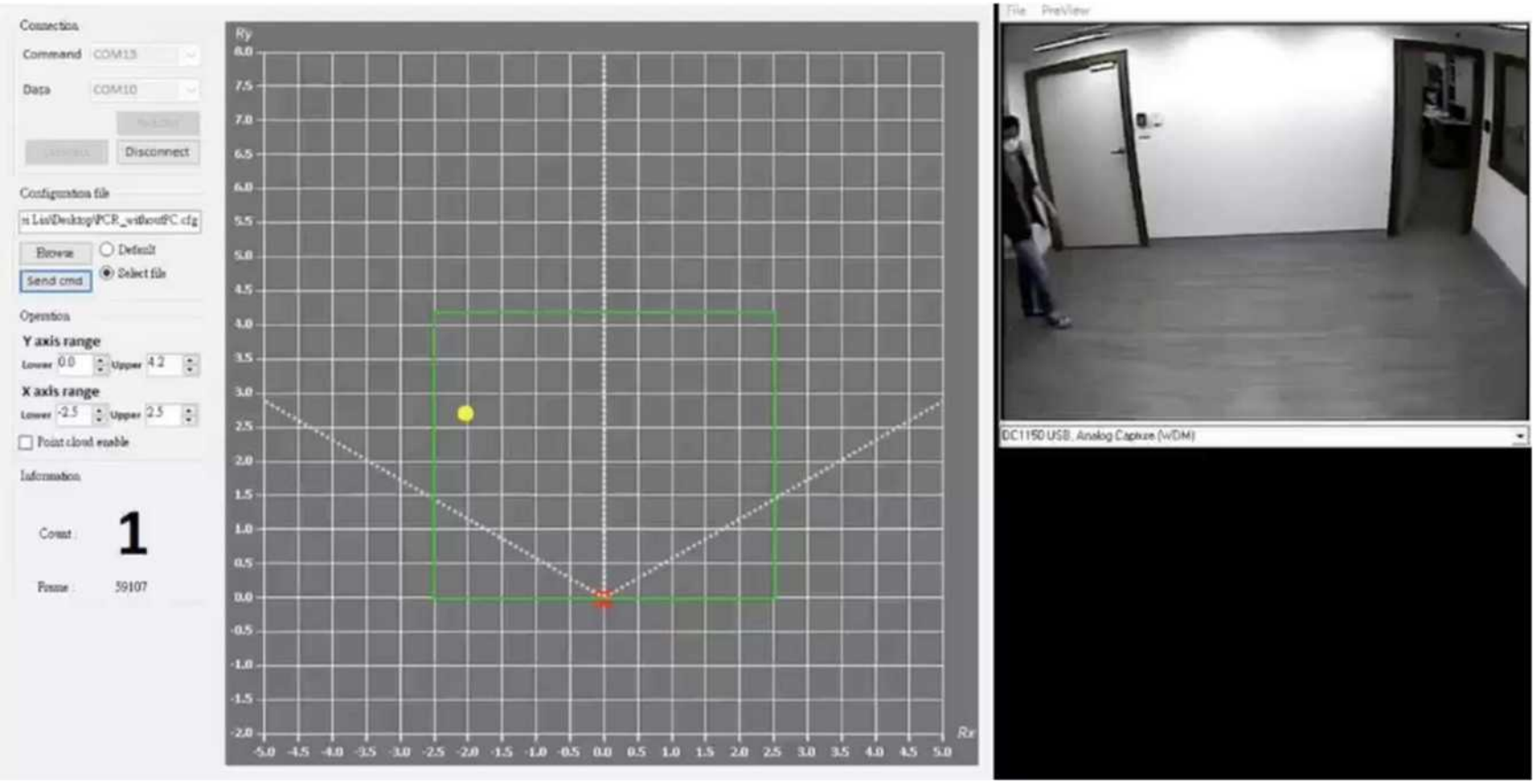
IMEC MULTIVIEW SOLUTION

- Use of cost-effective thermal sensors
- Use of mm-wave radar for people counting and tracking
- Low-cost RGB sensors with AI/ML for mask detection







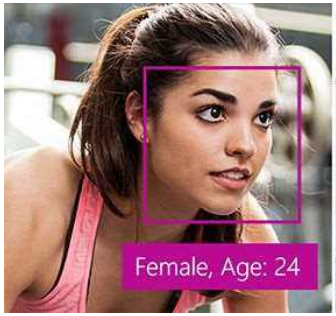

Connection
Command
COM13
Data
COM10
Disconnect
Configuration file
Browse
Default
Send cmd
Select file
Operation
Y axis range
Lower 0.0
Upper 4.2
X axis range
Lower -2.5
Upper 2.5
Point cloud enable
Information
Count
1
Frame
59107
Ry
Rx
File PreView
DC1150 USB Analog Capture (WDM)

CONCLUSION

License plate recognition

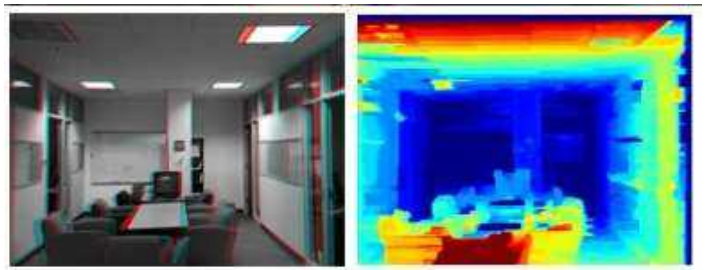
Bin Picking

Gesture detection

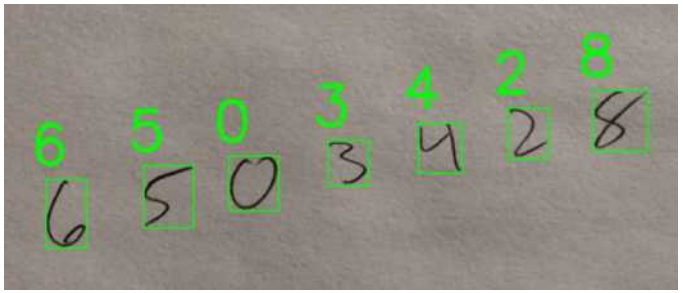


Face detection age/gender classification

Barcode reading



Stereovision



OCR

Color classification

Object tracking

Quality Inspection

CONCLUSION

- imec is your ideal partner for tailor made vision and imaging solutions
  - Strength of combining multiple vision sensing technologies together
  - Access to cutting-edge technology
  - From idea to mass-production
  - One-stop-shop

- Need more information or want to discuss your vision problem ?

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at imec, we shape the future

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