

Machine Vision for Industry and Automation 2021

Market and Technology
Report 2021

TABLE OF CONTENTS

Part 1/2

Glossary and definitions	2
Table of contents	3
Report objectives	5
Scope of the report	6
Report methodology	9
What we got right, what we got wrong	10
About the authors	11
Companies cited in this report	12
Executive summary	14
Context	34
○ Global market trend	
○ Structure of machine vision	
○ History of industrial vision	
○ Evolution of industrial cameras	
○ Automation market trend	
○ Covid-19 impact	
Market forecasts	49
○ Market segmentation	
○ Breakdown by applications (main applications)	
○ Camera market overview	

○ Camera	
• Camera market revenue forecast (\$M) - By market segment	
• Camera market volume forecast (kunits) – By market segment	
• Camera market revenue forecast (\$M) - By application	
• Camera market volume forecast (kunits) – By application	
○ Image sensor	
• Image sensor market revenue forecast (\$M) - By market segment	
• Image sensor market volume forecast (kunits) – By market segment	
• Image sensor market revenue forecast (\$M) - By application	
• Image sensor market volume forecast (kunits) – By application	
○ Market growth analysis	
Supply chain	81
○ Industrial vision - merger & acquisition activity	
○ Industrial vision competitive & landscape 2020	
○ Evolution of machine vision cameras	
○ Camera supplier breakdown	
○ Image sensor supplier breakdown	
○ Industrial vision ecosystem - analysis	

TABLE OF CONTENTS

Part 2/2

Applications

- Market segmentation
- Factory automation applications
- Automatic data capture applications
- Automation applications in agriculture
- Automation applications in logistics
- Machine vision – food sorting
- Automatic number plate applications
- Market trend analysis

94

Technologies

- Camera technologies
 - Camera types
 - 3D camera
 - Hyperspectral image
 - Camera lenses
 - Camera interface

130

○ Image sensor

- Sensor pixel size roadmap
- CCD to CMOS
- Global shutter technologies
- EMERGING technologies
- Camera & image sensor technologies – analysis

Conclusion

184

How to use our data?

188

Yole Group of Companies presentation

189

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Biographies & contacts



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Prior to Yole, Richard was engaged in camera module design on image sensor, AF/OIS at Onsemi, before this, he worked as a customer-application-technologist in Micron/Aptina Imaging. Richard has over 12 years post graduate experience in both of imaging semiconductor and camera module industry, he has the successful track record in developing projects for the tier one smart phone and module makers, which brought him wide industry connection in the CMOS image sensor supply chain and ecosystem

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- › Excel files with graphics and data

Topics

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- › Lighting & Displays
- › Power Electronics & Battery
- › Compound Semiconductors
- › Semiconductor Manufacturing and Packaging
- › Computing & Memory

115+ reports per year

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Topics

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- › Application Processor
- › DRAM
- › NAND
- › Compound Semiconductor
- › CMOS Image Sensors
- › Smartphones

7 different monitors quarterly updated

WEEKLY TRACKS

Insight

- › Teardowns of phones, smart home, wearables and automotive modules and systems
- › Bill-of-Materials
- › Block diagrams

Format

- › Web access
- › PDF and Excel files
- › High-resolution photos

Topics

- › Consumer: Smartphones, smart home, wearables
- › Automotive: Infotainment, ADAS, Connectivity

175+ teardowns per year

CUSTOM SERVICE

Insight

- › Specific and dedicated projects
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- › Reverse costing and reverse engineering

Format

- › PDF files with analyses
- › Excel files with graphics and data

Topics

- › Photonics, Imaging & Sensing
- › Lighting & Displays
- › Power Electronics & Battery
- › Compound Semiconductors
- › Semiconductor Manufacturing and Packaging
- › Computing & Memory

190 custom projects per year

SCOPE OF THE REPORT

Cameras and systems

IN SCOPE

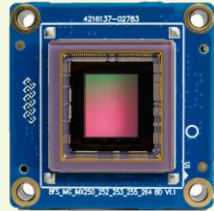
Non-application specific cameras



Courtesy of Basler

Industrial PC-based cameras

Highest specifications



Courtesy of FLIR

Industrial board cameras

Highly integrable



Courtesy of Cognex

Industrial smart cameras

User-friendly

Application specific systems

Systems for ANPR



Systems for ADC



ANPR: Automatic Number Plate Recognition
ADC: Automatic Data Capture

OUT OF SCOPE

Lenses



Lighting



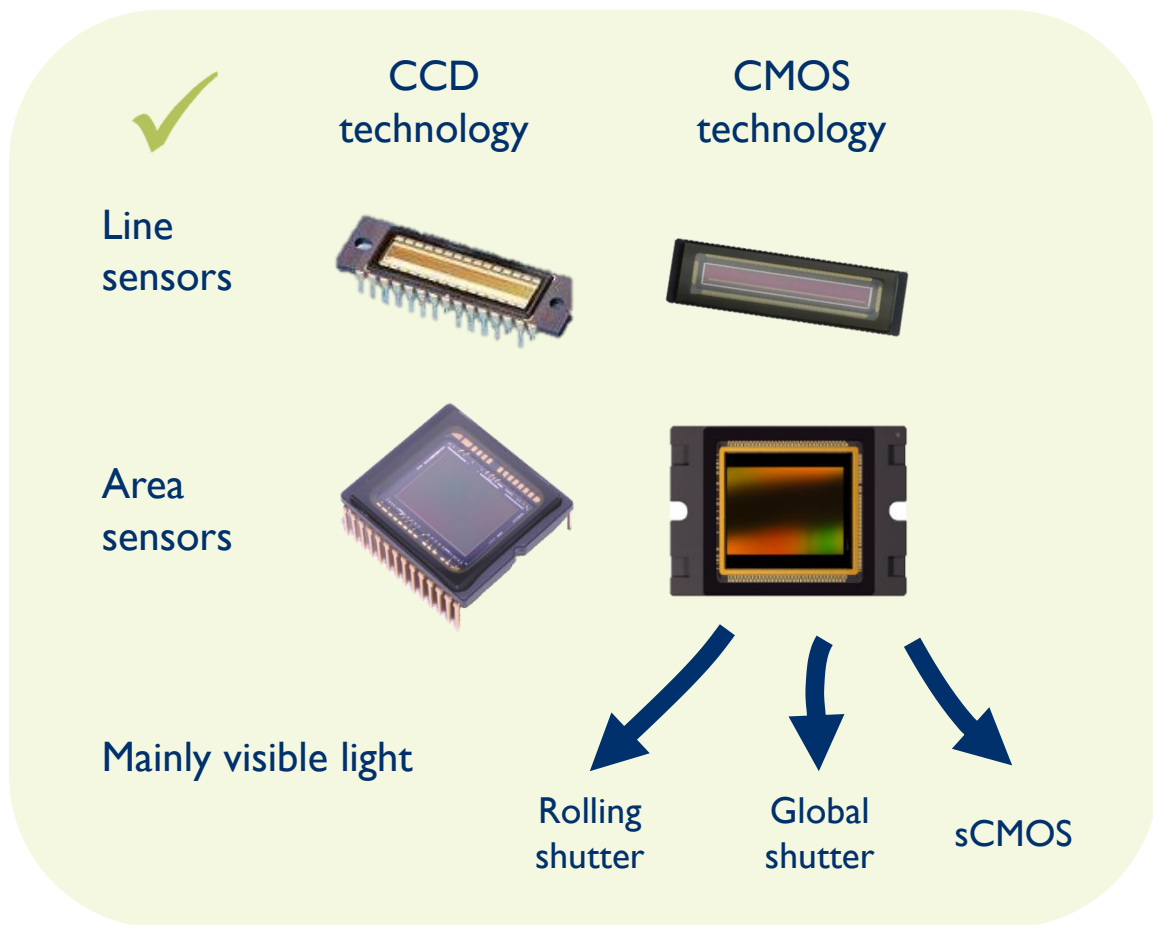
Cables



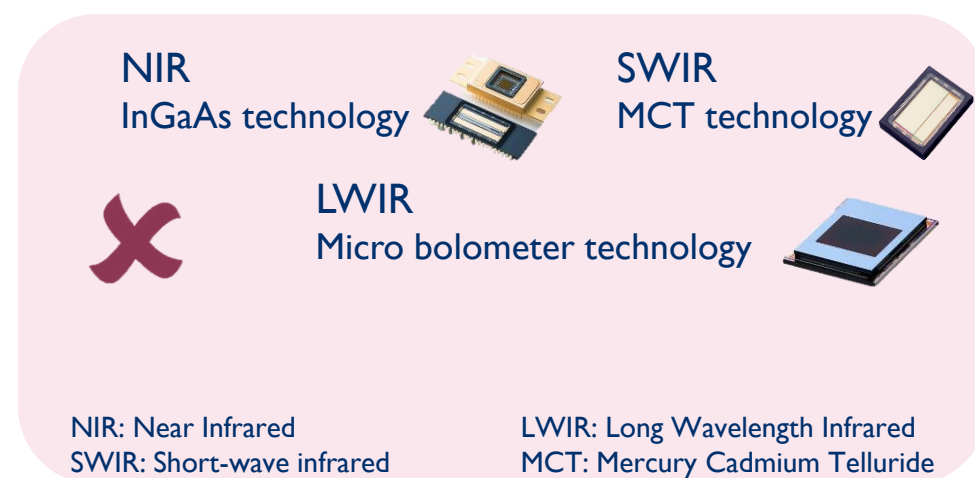
SCOPE OF THE REPORT

Image sensors

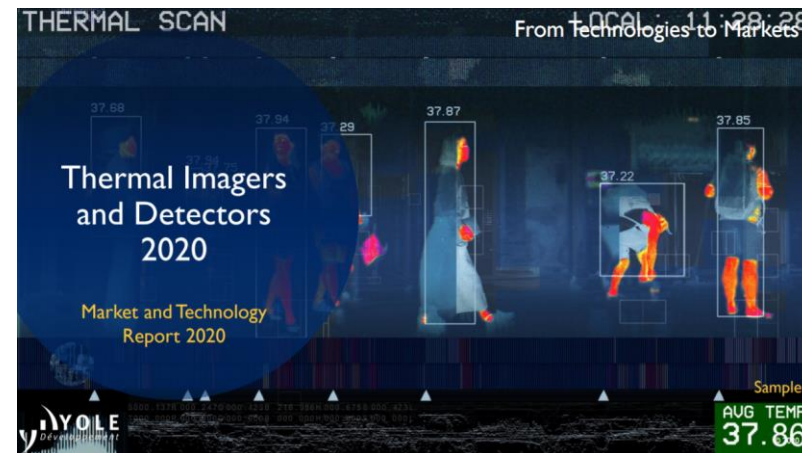
IN SCOPE



OUT OF SCOPE

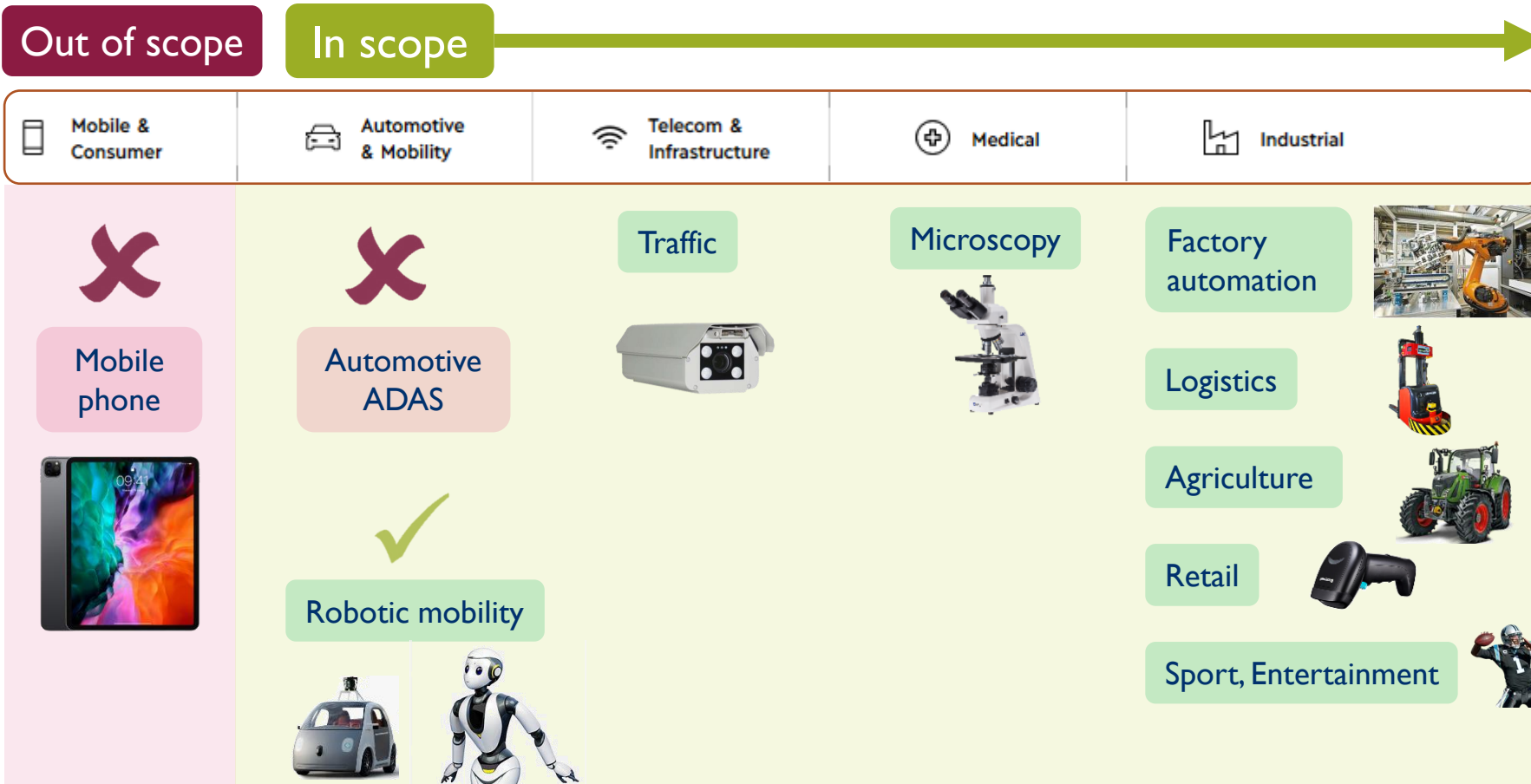


You might consider reading the [Thermal Imagers and Detectors 2020](#) from Yole.



SCOPE OF THE REPORT

Markets and applications



Consumer camera applications are covered in Yole's camera module report.

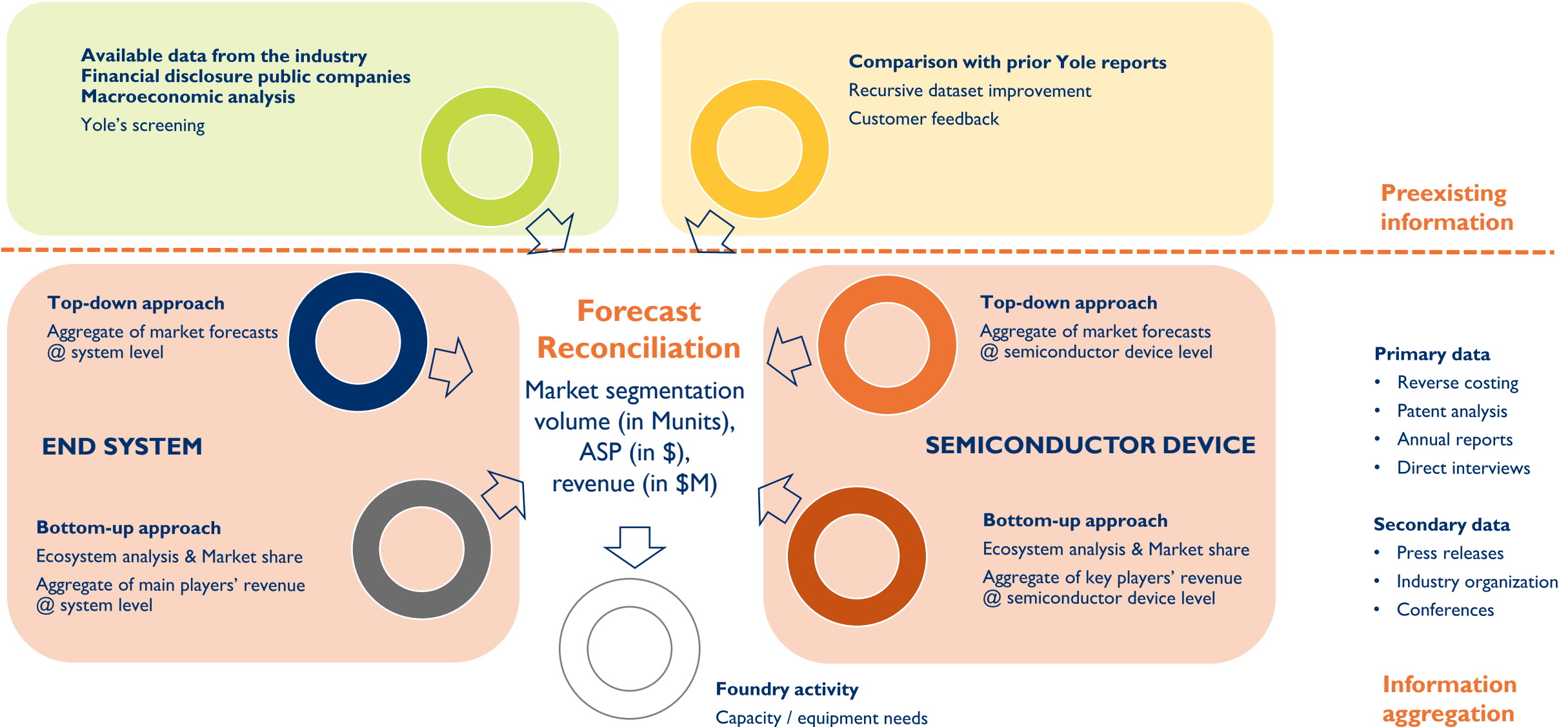
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METHODOLOGY & DEFINITIONS

Yole's market forecast model is based on matching heterogeneous sources:



COMPANIES CITED IN THIS REPORT

3M, Adimec, Allied Vision Technologies (AVT), ams, ARH Inc., Axis AB, Banner Engineering, Basler AG, Baumer Electric AG, BaySpec, Bosch Security Systems, Brandywine Photonics, Buhler GmbH, CA Traffic Limited, Chromasens GmbH, Cognex Corp., Compac, Cubert GmbH, Daewon GSI Co., Ltd., Datalogic, Daheng, Delta Optical Thin Film A/S, Delta Technology Corp., Digital Recognition, ELSAG, FLIR Integrated Imaging Solutions Inc., Flo-Mech, Genetec Inc., Gilden Photonics, Gpixel, Hamamatsu Photonics KK, Huaray, Headwall Photonics, Hefei Angelon Electronics Co., Hefei Growking, Hikrobot, Optoelectronic Technology Co., Hefei Meyer Optoelectronic Technology Inc., Hefei Taihe Optoelectronic Technology, Hitachi Kokusai Electric Inc., Honeywell, HySpex, IC Intracom, ifm electronic GmbH, Imaging Development Systems GmbH (IDS), JAI A/S, Jenoptik Traffic Solutions UK Ltd., Key Technology, Keyence, Leica Microsystems, LMI Technologies, Lumenera Corp., Matrox, MAV Systems, Microscan Systems, Inc., Motorola, Newland, NDI Recognition Systems Ltd. (NDI-RS), Neology Inc., NET GmbH, Nikon, Nippon Electro-Sensory Devices Corp. (NED), Nippon Electro-Sensory Devices Corporation, Northrop Grumman, Olympus Corporation, Omron, Omnivision, Omron Sentech Co., ON Semiconductor, Photometrics, Pixelteq, Q-Free ASA, Quercus Technologies, Resonon, Satake Group, Sesotec GmbH, Sick AG, Siemens AG, Smartek vision, SmartSens, Sony Imaging Products & Solutions Inc., Sony Semiconductor Solutions Corporation, Specim, Stemmer Imaging, SVS-Vistek GmbH, Symbol, Tattile SRL, Teledyne Dalsa, Teledyne e2v, Thorlabs, TKH Group, Tomra Sorting Solutions, Toshiba Teli Corp., Unitech Electronics Co., Viavi Solutions, Vieworks Co., Vision Components GmbH, Wasp Barcode Technologies, Xenics, Ximea GmbH, Zebex Industries Inc., Zebra Technologies, and more.

WHAT WE GOT RIGHT, WHAT WE GOT WRONG

Technology and market forecast challenges

What we got right

- Industrial vision image sensor revenue forecast in 2019, a value of ~\$400M
- The trend to move from CCD to CMOS, CCD only has around 10% market share in 2020
- Development of smart cameras and board cameras is within expectations
- Low light sensitivity of CMOS image sensors is continuing to be improved using BSI technology and the sensors are shrinking with smaller pixel sizes



What we got wrong

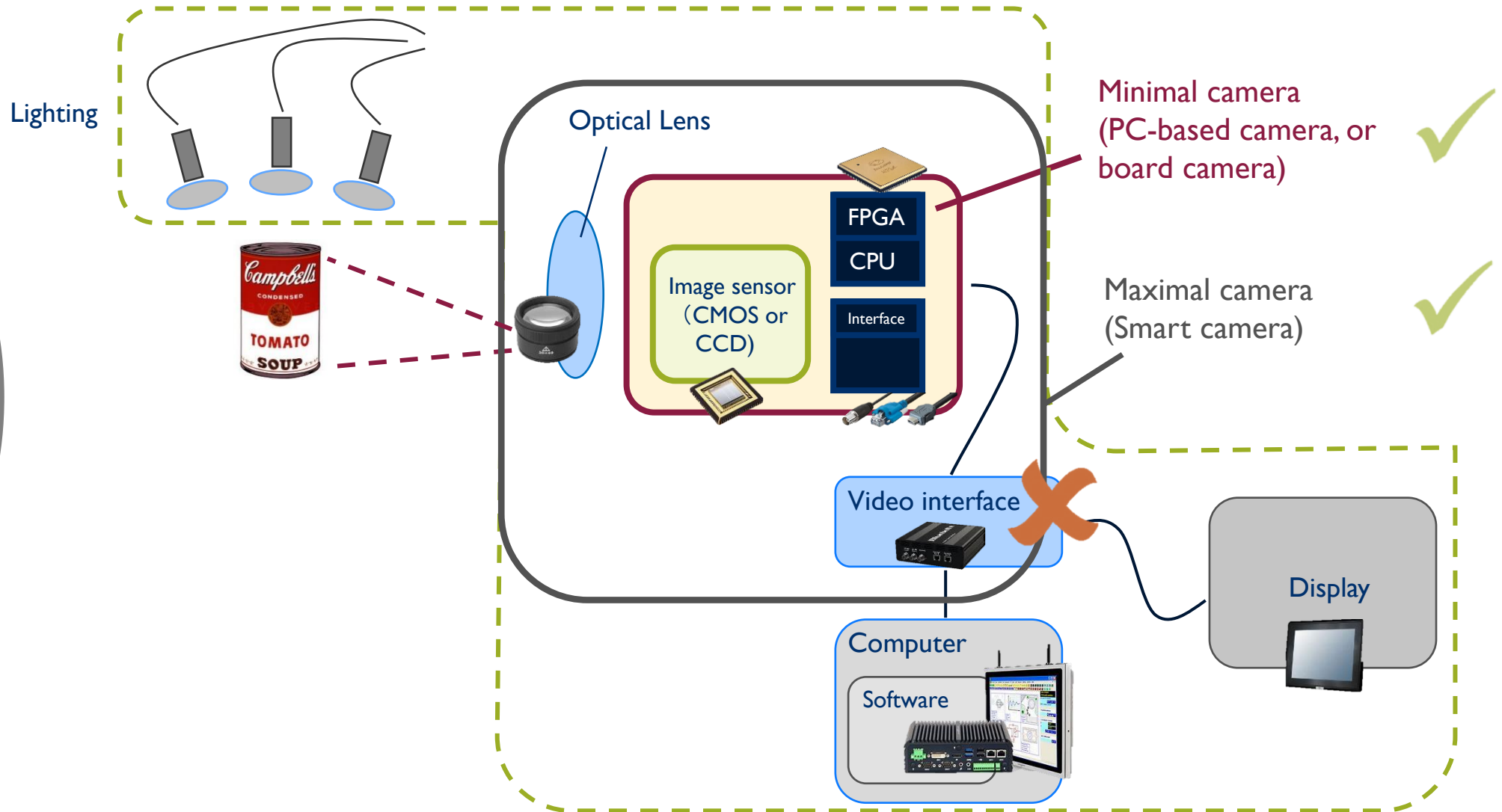
- The total industrial vision market shot up over 20% from 2017 to 2018
- Emergence of the Chinese players
- The ratio of electronics and semiconductors in factory automation
- The emergence and growth of autonomous cars



KEY COMPONENTS OF MACHINE VISION

The PC-based or board camera and the smart camera

MV cameras can be comprised of discrete elements or may be integrated together into one unit, such as a smart camera.



EVOLUTION OF INDUSTRIAL CAMERAS



Industrial cameras are evolving in two opposing directions: smart cameras and board cameras.

PC-based Machine Vision system



The original machine vision system was PC-based. It still offers the best performance and most flexibility.

More features

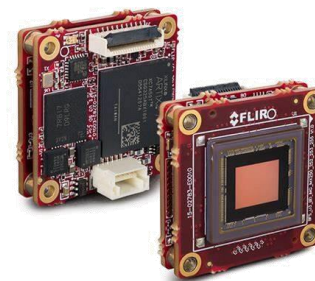
Industrial smart camera



The industrial smart camera is an evolution of the PC-based machine vision system. It is an integrated system with on-board computing capabilities. For the user, it is much easier to implement than the PC-based system. However, flexibility and performance is limited.

Naked

Industrial board camera

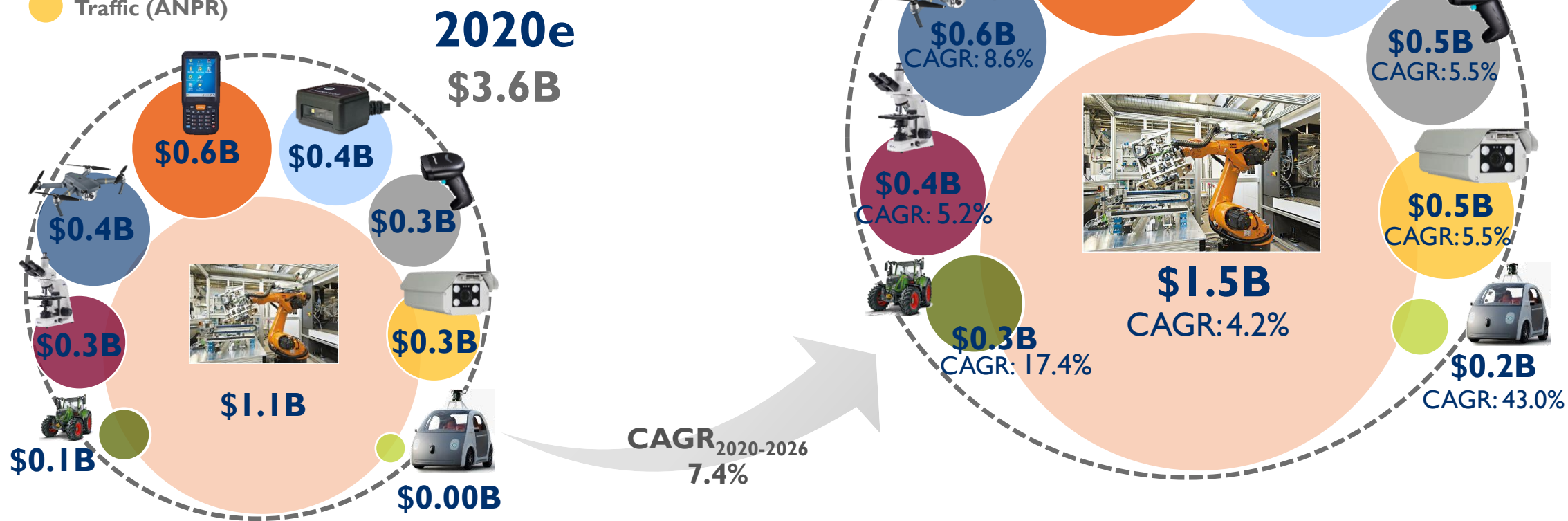


Industrial board cameras are a recent evolution of industrial cameras. The transition from CCD to CMOS has resulted in a simplification of the camera components, the camera being reduced to a single board. The industrial camera allows integration into new systems and may be an important component in the next evolution of machine vision.

INDUSTRIAL CAMERA MARKET FORECAST

Overview by application

- FA (Manufacturing)
- Logistic
- Other non-FA
- Factory ADC
- Medical
- Retail & other ADC
- Robotic mobility
- Agriculture
- Traffic (ANPR)

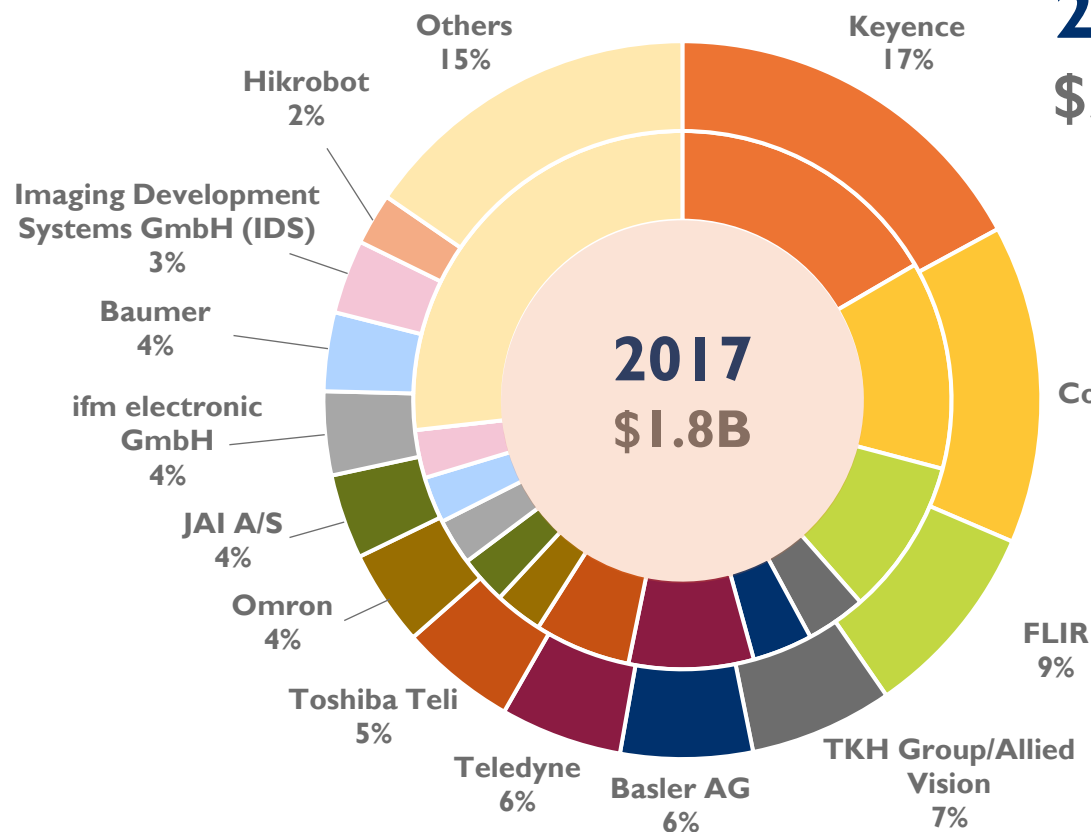


The industrial vision market is expected to grow from \$3.6B in 2020 to \$5.5B in 2026

MACHINE VISION CAMERAS

2019 market shares

Machine vision cameras are characterized by a multiplicity of players.



2019
\$2.3B



Cognex Corp.
14%

Company	2019 revenue(\$M)
Keyence	\$386
Cognex Corp.	\$324
FLIR	\$202
TKH Group/Allied Vision	\$146
Basler AG	\$134
Teledyne	\$124
Toshiba Teli	\$118
Omron	\$97
JAI A/S	\$86
ifm electronic GmbH	\$85
Baumer	\$80
Imaging Development Systems GmbH (IDS)	\$75
Hikrobot	\$52
Others	\$348

CMOS IMAGE SENSOR TECHNOLOGY

Pixel sizes in 2019-2020

Pixel size will govern the achievable resolution for a given sensor size/price.



ON Semiconductor®

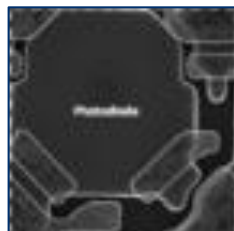
Sensor size: 1/2.6" inch
Global shutter
pixel

Pixel size: 3.0µm



1/5" inch
Global shutter
pixel

3.0µm



Pregius S
1.1" inch
Global shutter
pixel

2.74µm



1/4" inch
Global shutter
pixel

2.7µm



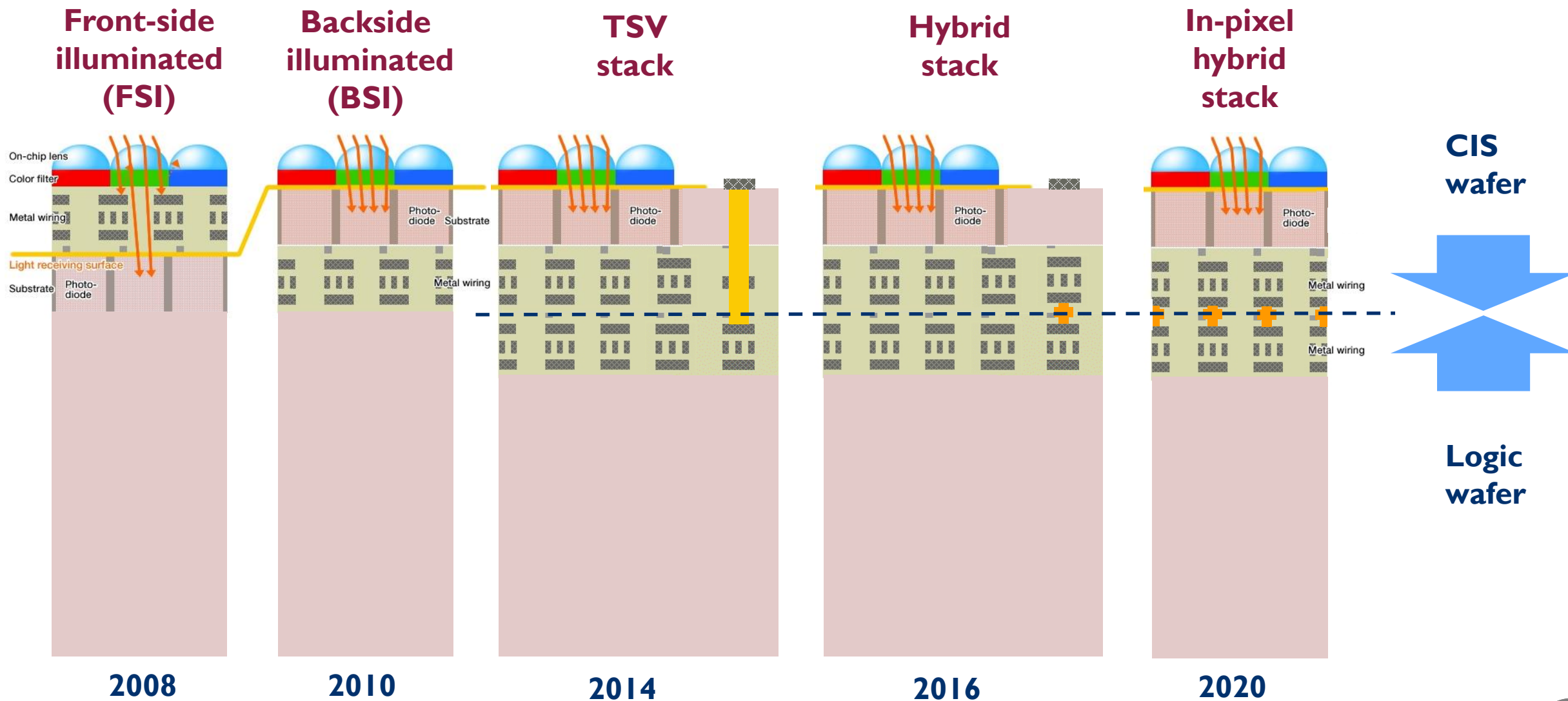
1" inch
Global shutter
pixel

2.5µm



CMOS IMAGE SENSOR TECHNOLOGY

BSI has opened the way for 3D semiconductors



CIS wafer

Logic wafer

2008

2010

2014

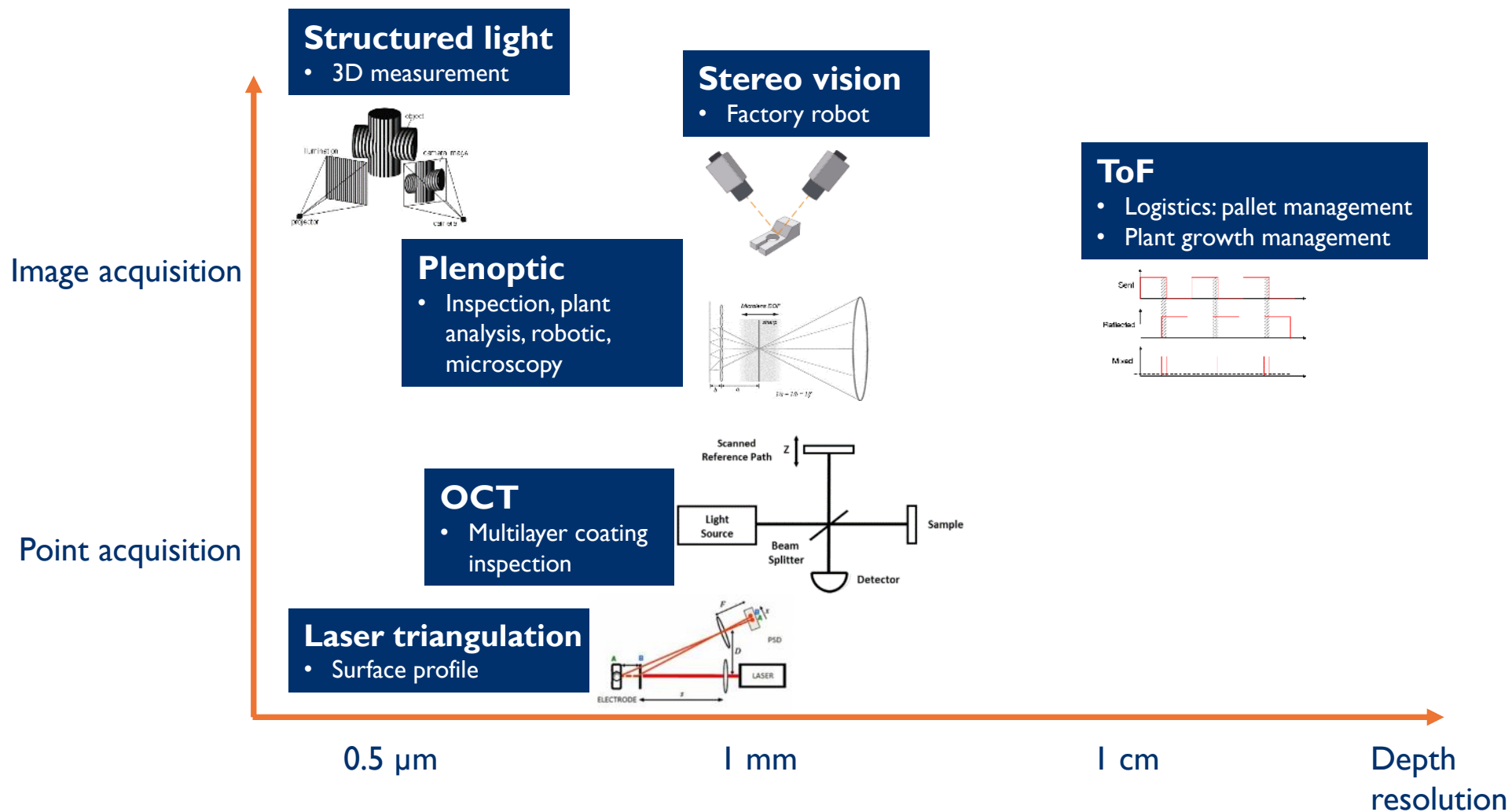
2016

2020

3D CAMERA TECHNOLOGIES

Performance, applications, and technics

Various 3D Technologies offer various specifications.

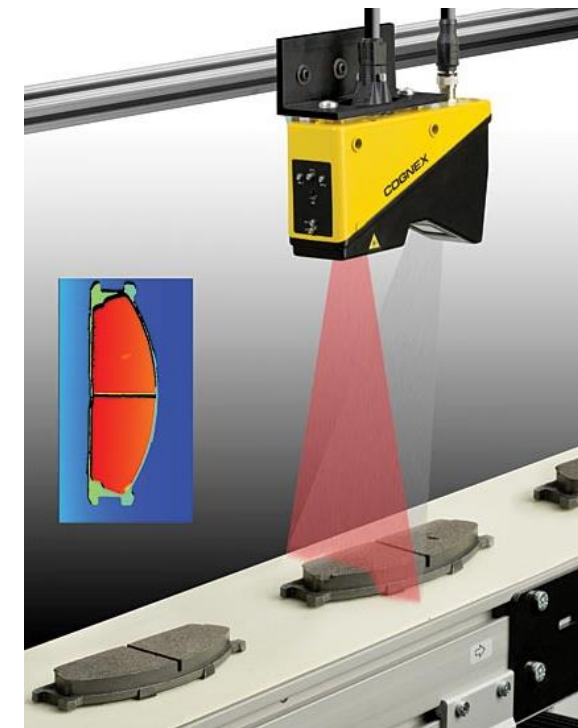
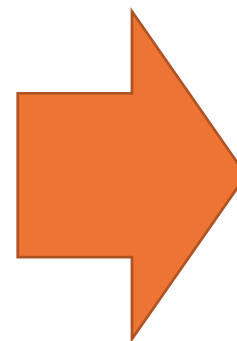
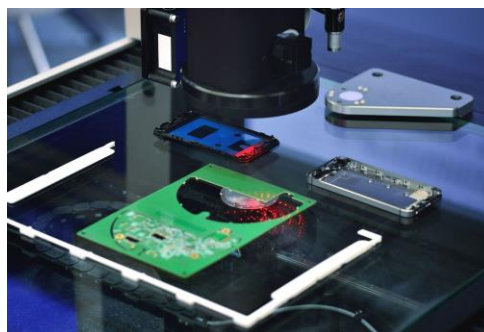
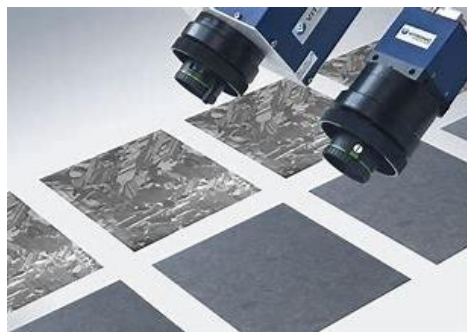
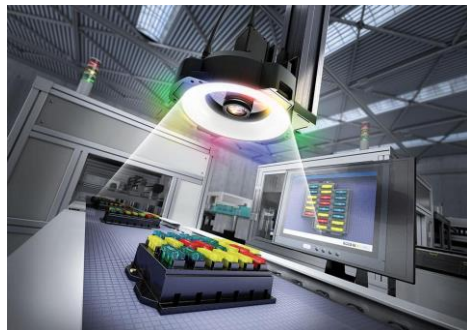


OCT: Optical Coherence Tomography
ToF: Time of Flight

FACTORY AUTOMATION APPLICATIONS

Visual inspection

Quality control currently requires a lot of human visual inspection, and machine vision is the key to replacing them in this field.



Courtesy of Cognex

Inspection of defects, contaminants, functional flaws, and other irregularities in manufactured products. Examples include checking the colors, verifying the surface and confirming contaminant presence, or touch screens to measure the level of backlight contrast.

3D cameras can perform more complex detection tasks, such as reading embossed or raised characters such as those on automobile tires etc.

DRIVERS FOR ROBOTIC CARS

Car bans

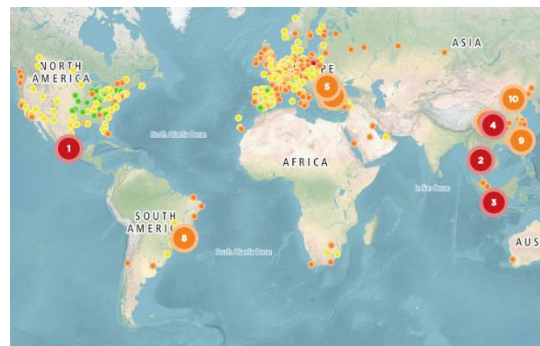
Developed countries are removing cars from large cities in order to fight **pollution**. Parking **costs** have also increased significantly.



Paris mayor proposed to ban petrol cars by 2030.

Traffic congestion

In **developing** countries, there is major traffic **congestion** due to a lack of efficient public transportation. This problem could be solved by car sharing.



Courtesy of Tomtom

Sharing economy

The sharing economy has developed thanks to the Internet and smartphones. It is a new way of doing business, creating value, and being **cool**.

The sharing economy has been challenging the traditional economy in almost every sector.



Different markets will find value in robotic cars.



THREE-PAGE SUMMARY (1/3)

Market & players

- After the growth momentum slowed down in 2019, the economic activity in the industrial vision market had a temporary influence in 2020 due to COVID-19. However, the market demand did not disappear, especially the rapid recovery in the Asia-Pacific region, which stabilized the overall market with a decrease rate of only -2%.
- The industrial vision ecosystem is still dominated by players from industrialized countries (US, EU), though has numerous players and is fragmented. The emergence of Chinese players is nevertheless noticeable. Some distributors, equipment suppliers and security camera suppliers have entered the market enabling innovative solutions and lower-priced cameras in the region. Prominent players are Hikrobot (part of Hikvision) and Huaray (part of Dahua).
- With total industry camera revenue of \$3.6B in 2019, Keyence remains the biggest industrial camera player, With a market share of 17.0%, Cognex 14.0% and FLIR 9.0%. The rest players are also focusing on different area of industrial with high competition each other.
- Factory automation keep the biggest part for machine vision with 62% of market revenues, Robotic mobility has emerged has significant market sub-segments with growth beyond 30% CAGR. Automatic data capture applications are more centralized, mainly in retail, logistics, less revenue but high demand in quantity, they have 71% volume of ADC market.
- Yole Développement envision a bright future for industrial vision at 7.4% CAGR, with tighter links to the growth of industrial in general, it is expected to reach \$5.5B in 2026.

THREE-PAGE SUMMARY (2/3)

Technology trend

Industrial vision systems is designed to use information extracted from digital images to automatically guide manufacturing and production operations through cameras:

- MV continue to shift from PC-based to board cameras and smart cameras
- Lenses are also evolving as the market gets bigger, and liquid lenses are the next big thing
- The number of multispectral cameras accounted for nearly 5% of the market in 2020, it will further develop multi-spectral cameras to meet the needs of the market
- 3D imaging allows a more complete visual of a product enabling better quality tracking, which could further increase the market share from current 7% in revenue
- AI and machine learning (processor) could give machine cameras more power or change the shape of the cameras, 5G communication could accelerate this trend

CMOS image sensor (CIS) is now dominating the industrial vision market, with a 92% of market sales, while CCD will continue to decline, and remaining in niche, high-end areas such like medical and defense.

- Reduction of pixel size shrinking is the underlying trend bringing additional performance
- Stacking of image sensors over logic IC further accelerate image processing circuits and pixel integration, leading to new types of chips : GS, 3D ToF, Quantum, Event Based...
- AI will be the next level of integration

THREE-PAGE SUMMARY (3/3)

2020 conclusion

- Under COVID-19 situation, the industrial vision market was little affected.
- The short-term impact for industrial cameras will be declined this year with a -2% YoY and \$3.6B expected result for 2020.
- Yole expected 2021 will be recovery strongly with a 19% YoY and will reach \$4.2B with end of COVID-19.
- On the medium term the industrial vision is expected to grow 7.4%, well ahead of global industrial growth.
- The industry vision is currently dominated by CMOS image sensor, while benefiting from favorable global tailwinds:
 - Camera subsystems price erosion
 - AI, 5G, 3D new technology development
 - Automatization of global manufacturing industries
- New opportunities for MV such as robotics and check-out-free retail are emerging: these new stories will reveal themselves in the next 5 to 10 years.

YOLE GROUP OF COMPANIES RELATED REPORTS

Yole Développement

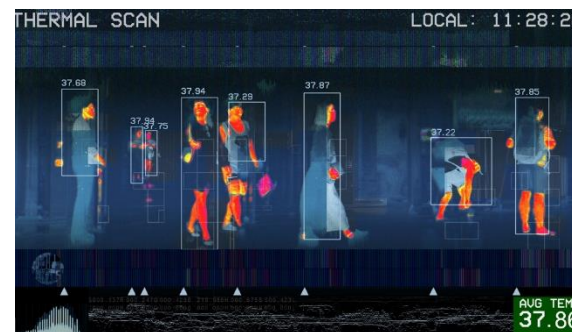
Contact our
Sales Team
for more
information



Sensors for Robotic Mobility 2020



Thermal Imagers & Detectors 2020



3D Imaging & Sensing 2020



CMOS Image Sensor Quarterly Market Monitor



HOW TO USE OUR DATA?

Yole Group of Companies, including Yole Développement, System Plus Consulting and PISEO, are pleased to provide you a glimpse of our accumulated knowledge.

We invite you to share our data with your own network, within your presentations, press releases, dedicated articles and more, but you first need approval from Yole Public Relations department.

If you are interested, feel free to contact us right now!

We will also be more than happy to give you updated data and appropriate formats.

Your contact: Sandrine Leroy, Dir. Public Relations
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