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Home-Grown Market Leaders Expanding Amid Machine Vision Industry Boom

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Horizon Insights (Shanghai) Investment Consulting Co., Ltd

◆ **Technology**

◆ **Energy & Manufacturing**

◆ **Consumer & Media**

◆ **Healthcare**

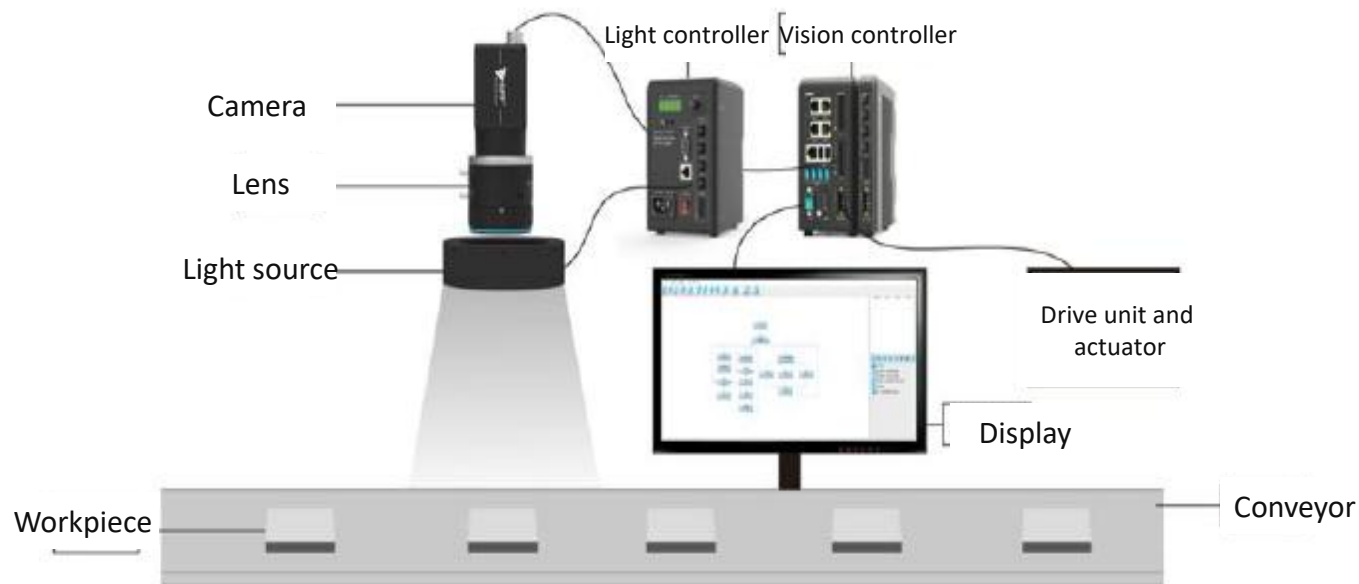# Machine Vision Technology Market Leader in China: OPT (688686.SS)

- **Machine Vision Industry:** Amidst a precision machine automation trend, machine vision technology has been applied to increasingly widespread of new businesses, bolstered by more powerful hardware and software features such as precise imaging accuracy and image processing algorithm optimization. Smart industrial manufacturing industries, especially in new energy sectors such as electric vehicles and lithium battery production, have also added to the machine vision boom and accelerated its advancement.

- **Home-grown Chinese manufacturers have shown huge growth potential in machine vision industry.** Global leaders in machine vision technology like Cognex have built a library of database and a series of hardware and software products in traditional industries in order to expand from ad hoc industry solutions to mass production of standardized products and systems. Chinese manufacturers, albeit with shorter development time, are closing the gap with global leading industry peers. China's domestic market has shown huge growth potential for upstream machine vision products and components in the areas of 1) 3C consumer electronics manufacturing, 2) new energy battery production, and 3) automotive & semiconductor manufacturing industries. Accordingly, home-grown Chinese manufacturers have shown obvious competitive advantages in terms of 1) a well-established domestic supply chain network, 2) customized service capability, 3) rapid response to customer needs, and 4) industry specific technical know-how.

- **OPT Machine Vision Tech Co. Ltd. (688686.SS)** is a leading machine vision company in China. The company has grown from a light source hardware provider to a machine vision system solution provider over the past 16 years, covering sectors in 3C consumer electronics, new energy battery production, and automotive & semiconductor manufacturing. The company has provided customized solutions for important clients such as Apple and Contemporary Amperex Technology Co. Limited (CATL – a lithium battery manufacturer). OPT has also continued to use its accumulated know-how and industry position to further expand into various other applicable segments with its standardized products. For example, OPT's 3C consumer electronics business has steadily grown from component assembly to entire modules, and from cell phones to watches, iPads, and other consumer electronics categories. In addition, the company's new energy battery business is booming due to a domestic lithium battery expansion wave. Furthermore, OPT's automotive business is already supplying the Tesla supply chain system, which represents another potential new growth area for the company. In the short term, the company is expected to enjoy a combination of an industry boom and high company growth in the machine vision industry. In the mid-to-long-term, OPT will benefit from its well-entrenched competitive advantages and a clear pathway for further future sales growth in the years ahead.

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Machine vision is an automated technology that reads captured images and process it in order to perform intended functions like inspecting finished products

- Machine vision is a combination of hardware and software for industrial and non-industrial applications, providing operational guidance for a device to perform its functions based on captured and processed images. Machine vision can be divided into two main components: imaging and image processing & analysis, with the former achieved via the hardware of the machine vision system, while the latter through the vision control software system.

Typical machine vision system structure

Light controller | Vision controller

Camera

Lens

Light source

Drive unit and actuator

Display

Workpiece

Conveyor

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Far better than human vision in speed and accuracy, with functions such as recognition, measurement, positioning, and inspection of intended items

Machine vision can replace human eyes in a variety of scenarios such as reading QR codes and determining the positioning of assembled parts. The applications and functions of machine vision can be grouped into four basic types: recognition, measurement, positioning and inspection.

- Recognition is to determine target objects based on their features such as shape, color, character, barcode,…etc. The accuracy and speed of recognition are the main indicators of this function.

- Measurement is the process of calibrating the acquired image pixel information into commonly used measuring units and then calculating the precise geometry of the target object in the image. High precision as well as complex morphological measurements are the strengths of machine vision.

- Positioning is the acquisition of position information of a target object, either in two or three dimensions. The accuracy and speed of positioning are the main indicators of this function.

- Inspection generally refers to cosmetic inspection and detection such as product integrity inspection after assembly (e.g. to ensure right components are installed in the right positions after they are placed on the printed circuit board), and surface defects detection (e.g. to detect scratches or dents).
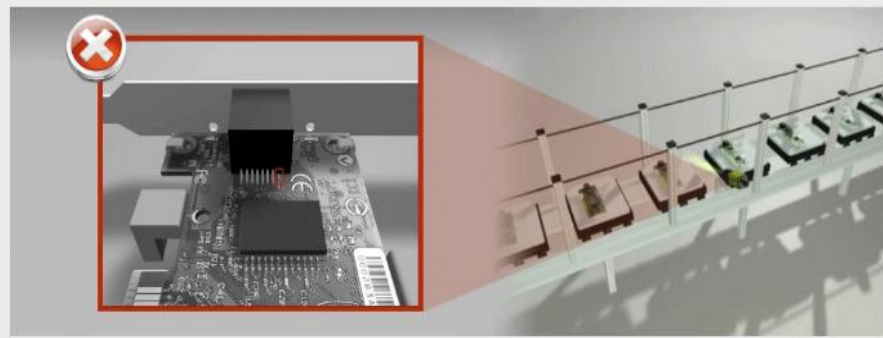
Advantages of machine vision vs. human vision

Performance indicators	Human vision	Machine vision
Speed	Slow, human eyes unable to see fast moving targets clearly under 0.1 seconds of visual transience; human brain processing and analysis speed of images affected by multiple factors, which vary greatly	Fast, shutter time able to reach about 10 microseconds, high-speed camera frame rate able to reach more than 1000; vision controller processing and analysis speed of images are stable and increasingly faster
Observation accuracy	Poor, 64 grayscale, unable to distinguish tiny targets	Strong, 256 grayscale, capable of observing micron-level targets
Environmental requirements	Weak, poor adaptability to environmental temperature and humidity, many environments are harmful to human body	Strong, highly adaptable to environments, protective devices can be added
Objectivity	Low, data unable to be quantified, varing from person to person	High, data able to be quantified, uniform standard
Reliability	Easily fatigued, affected by moods	Strong, able to work continuously, stable and reliable results

Four functions of machine vision

Difficulty (y-axis)

Recogniztion, Measurement, Positoining, Detection

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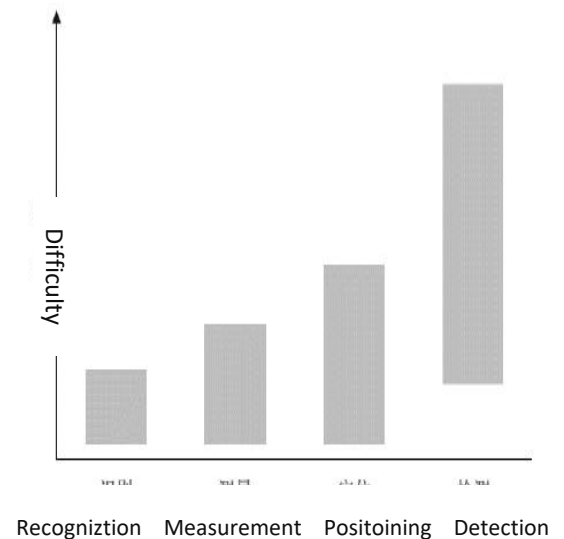
Machine vision application in the electronics industry such as bar code reading

视觉: 检测接头引线

视觉: 检查标签位置及其易读性

视觉: 验证关键组件的位置

视觉: 检测边缘接头轨道的质量

Information link: https://www.cognex.cn/zh-cn/applications/products-in-action/computer-inspection

Source: Cognex website. 4
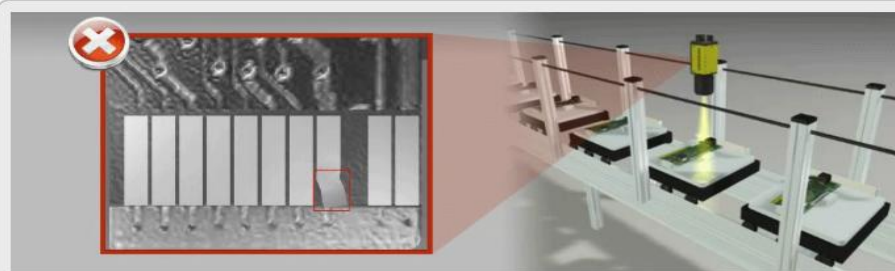
Machine vision application in the lithium battery manufacturing industry

Electrode
- Coating quality inspection, coating width gauging
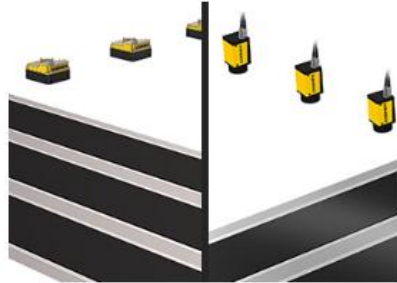
Formation
- Code reading, pouch surface inspection, cell stacking height measurement, optical character recognition
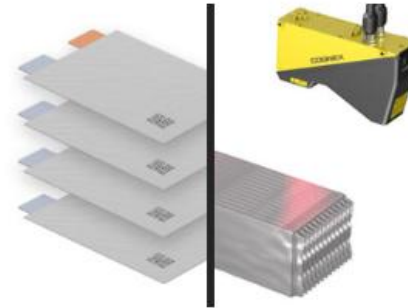
Assembly
- 2D code reading, cylinder inspection, cap welding inspection, electrode tab distance gauging, injection seal inspection, cap welding guidance and inspection, battery cell surface inspection, stacking alignment, side top panel welding inspection
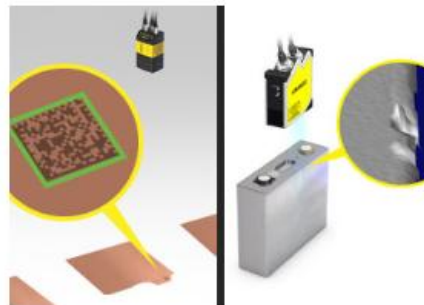
Module and pack system
- Barcode reading, module busbar inspection, M&P assembly and cable connector guidance, thermal interface material inspection

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Three major barriers to entry in machine vision sector: imaging hardware, vision analysis software, and overall industry knowledge and experience

- Core barriers of machine vision include imaging technology, vision analysis technology and industry know-how. Imaging technology can essentially achieve high precision, stable image acquisition using light sources, lenses, cameras, and controllers. Vision analysis requires a combination of 2D & 3D vision algorithms, deep machine learning, and image programming technology. Based on the imaging hardware, vision analysis software, and accumulated industry know-how from previous downstream industry applications throughout the years, machine vision systems have been greatly improved and are proven to be exceedingly reliable.
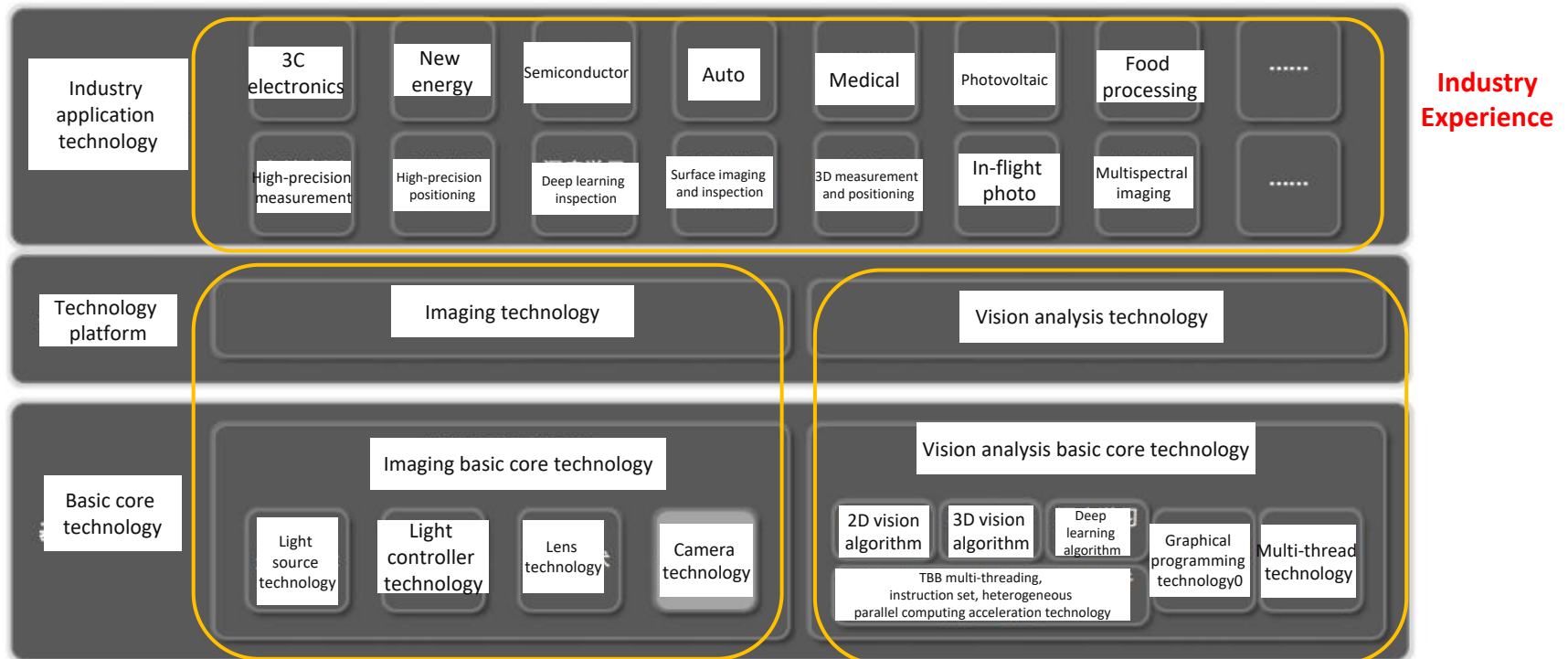
The machine vision technology system established by OPT

| Industry application technology | 3C electronics | New energy | Semiconductor | Auto | Medical | Photovoltaic | Food processing | ...... | **Industry Experience** |
| | High-precision measurement | High-precision positioning | Deep learning inspection | Surface imaging and inspection | 3D measurement and positioning | In-flight photo | Multispectral imaging | ...... | |

| Technology platform | Imaging technology | Vision analysis technology |

Basic core technology

Imaging basic core technology
- Light source technology
- Light controller technology
- Lens technology
- Camera technology

Vision analysis basic core technology
- 2D vision algorithm
- 3D vision algorithm
- Deep learning algorithm
- TBB multi-threading, instruction set, heterogeneous parallel computing acceleration technology
- Graphical programming technology0
- Multi-thread technology

Imaging core hardware   **Algorithmic software for vision analysis**

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Machine vision's core software and hardware components and working principle

Lens: starting point for capturing and transmitting information about subjects in a machine vision system, equivalent to the lens of human eyes.

Vision control system: analysis and processing of images obtained through light sources, lenses, and cameras.

OPT's vision system products

Light source: the role in machine vision mainly includes 1) illuminating the target, 2) highlighting features and forming effects that are conducive to image processing, 3) overcoming ambient light interference and ensuring image stability, and 4) serving as a tool or reference for measurement.

Lens Camera

SciVision Vision Development Kit
SciSmart Intelligent Vision Software

Light source

SciVision视觉开发包
SciSmart智能视觉软件

镜头 相机

光源

Vision controller

Light controller

视觉控制器

光源控制器

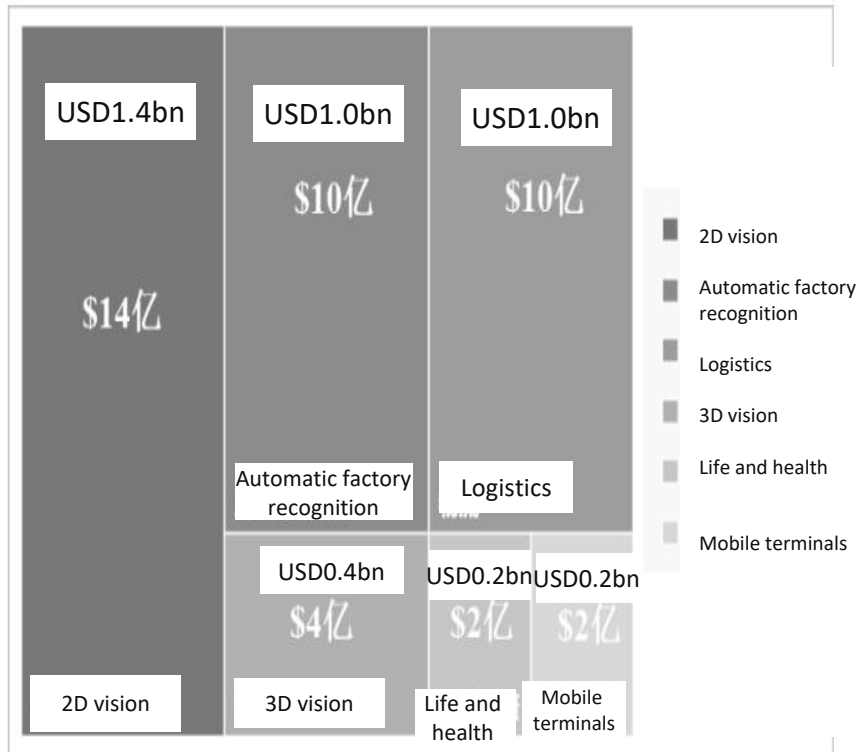**Camera:** light passing through the lens concentrates on the image plane to produce an image.

Light source controller: used together with light sources to provide a "seeing" environment for machine vision.
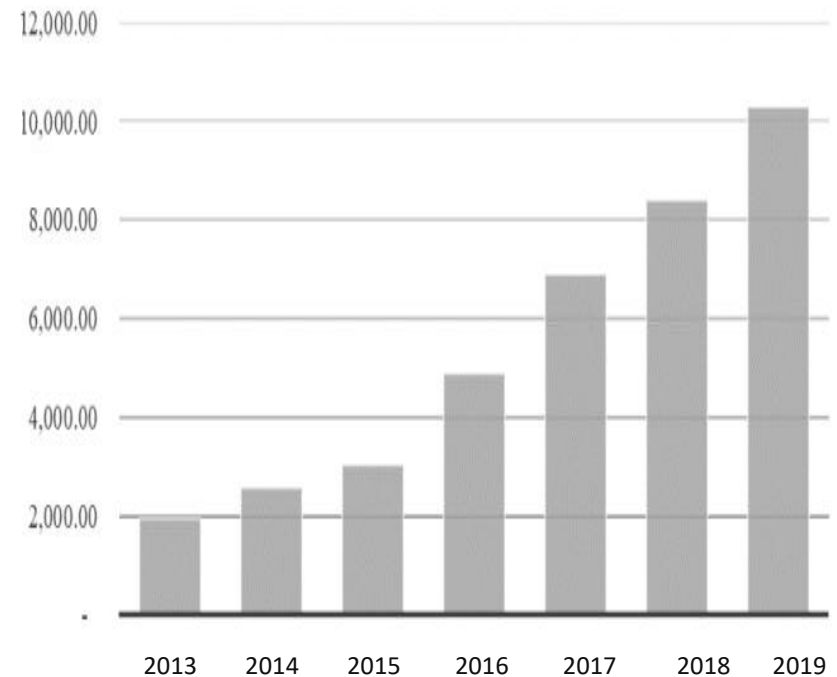
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China's machine vision market boom is boosted by demand from new energy and automotive industries, among other high precision manufacturing sectors

- According to Cognex estimates, the global machine vision market was approximately US$4.2 billion in 2018 and is expected to continue to grow at a CAGR of 12%. According to *China Machine Vision Market Research Report* published by the China Machine Vision Union (CMVU), the size of China's machine vision industry grew from 10.18 billion yuan in 2018 to 14.42 billion yuan in 2020, with a CAGR of 19.02%, and is expected to grow from 18.07 billion yuan in 2021 to 29.6 billion yuan in 2023, with a CAGR of 28.0%. Thanks to new energy battery and automobile capacity investment, new infrastructure investment, data center construction, and manufacturing automation advancement, China's machine vision industry is expected to be able to maintain its high growth momentum.

Global Machine Vision Market Size

USD1.4bn — 2D vision — $14亿
USD1.0bn — Automatic factory recognition — $10亿
USD1.0bn — Logistics — $10亿
USD0.4bn — 3D vision — $4亿
USD0.2bn — Life and health — $2亿
USD0.2bn — Mobile terminals — $2亿

Legend:
- 2D vision
- Automatic factory recognition
- Logistics
- 3D vision
- Life and health
- Mobile terminals

China machine vision industry size (million yuan)

Overseas leaders dominant in products, while home-grown players better at customized service, quick response, and emerging innovative applications

As of 2020, there are more than 300 machine vision agents for various products and more than 100 professional machine vision system integrators in China. The two main types of participants in the Chinese machine vision market now are old foreign machine vision companies (including branches and joint ventures in China) and emerging independent R&D home-grown players. Overseas manufacturers have significant advantages in product technology and performance, while home-grown domestic industry peers can better cater to emerging market demand and are better positioned in customized services, with quick response to customer needs.

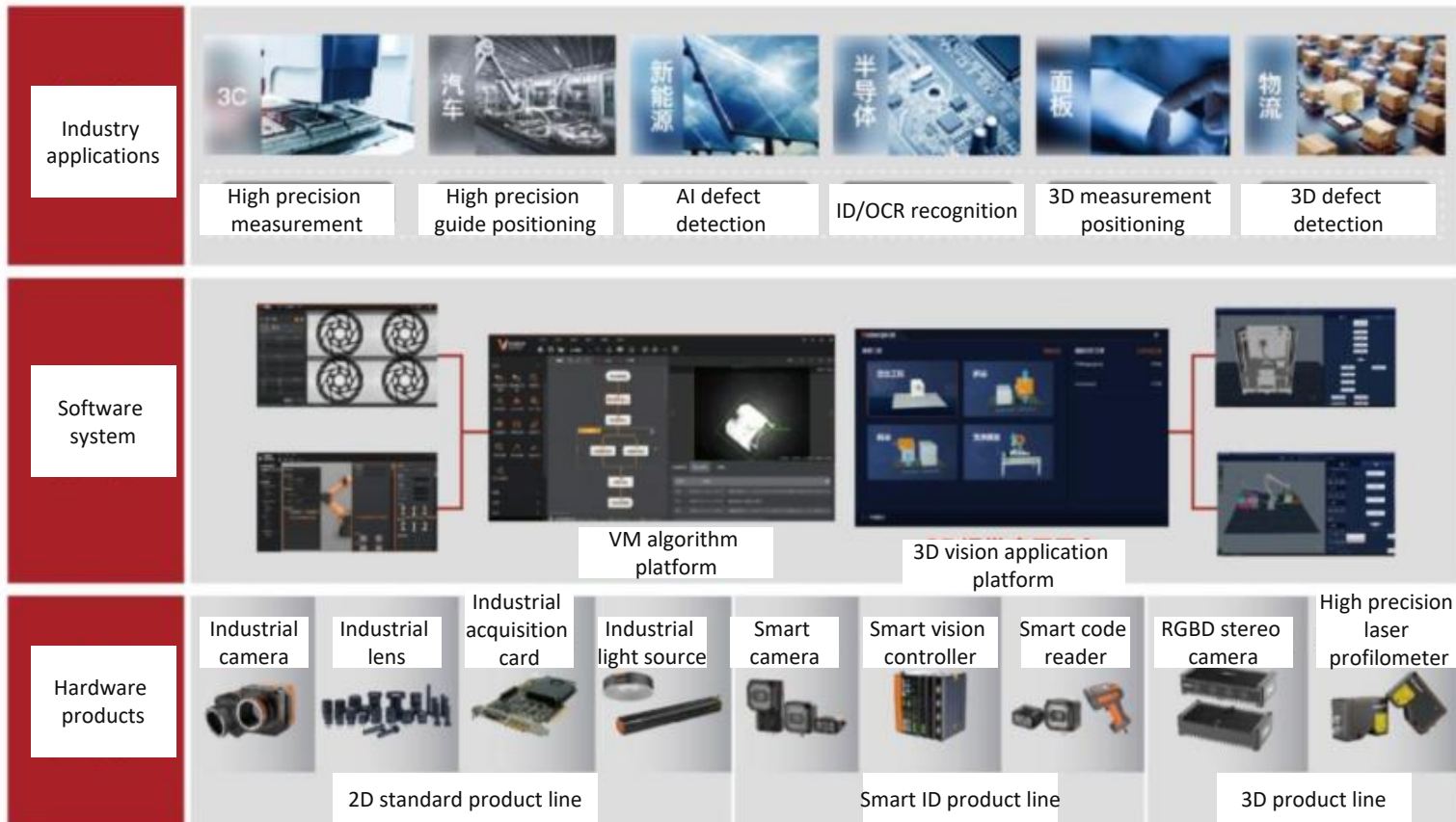| KEYENCE 基恩士 COGNEX 康耐视	OPT Machine Vision 奥普特 HIKROBOT 海康机器人
Advantages Long development time, high brand awareness, strong technical R&D capability, high product performance and reliability, rich selection of product types and solutions accumulated, better management, accurate judgment of market situation, and strong planning capabilities.	**Disadvantages** Relatively shorter development time, low popularity, weak technology R&D capability, performance and stability gap of self-developed products with foreign brands counterparts.
Disadvantages Standardized products, unlikely to meet many ad hoc application scenarios and customization needs of Chinese customers, and relatively high product price is a disadvantage amid rising cost pressure faced by customers.	**Advantages** Better understanding of Chinese market and customer needs, flexible and customized services, rapid response to customer needs, short delivery cycle, visible cost advantages, rising market share.

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Narrowing gap between Chinese manufacturers and overseas leaders

Company Name	Market Position	Operations (2021)
Keyence	Founded in 1974 and listed on the Tokyo Stock Exchange, one of Forbes list of 100 most innovative companies in the world from 2011-2018. Its products include sensors and measurement instruments, image processing equipment, control and measurement equipment, analytical equipment for R&D, and business information equipment.	**Revenue at 32.2 billion yuan and net profit at 11.8 billion yuan**
Cognex	Founded in 1981 and listed on the NASDAQ in the United States. Cognex is a leading global provider of machine vision products, including vision systems, vision software, vision sensors and industrial code readers.	**Revenues at 6.6 billion yuan and net profit at 1.8 billion yuan**
HIKROBOT	Hikvision subsidiary. Hikvision set up the subsidiary of Hangzhou Hikrobot Technology Co., Ltd. in 2016 on the basis of its former machine vision business division (established in 2014), which mainly operates three business segments: mobile robotics, machine vision and drones.	**2.76 billion yuan (including mobile robots, machine vision and drones)**
CCS	Founded in 1993, a global leader in light sources for machine vision. OPTEX, a company listed on the Tokyo Stock Exchange, acquired it in 2016 as a major player in its MVL (Machine Vision Lighting) business segment.	**Revenue at 670 million yuan**
Moritex	Founded in 1973 and headquartered in Japan, manufacturing and engaging in products related to applied optical devices and functional materials, including telecentric lenses for machine vision, bear-resistant macro lenses, and line-scan lenses.	--
Stemmer Imaging AG	A Germany-based supplier of machine vision technology with products from a variety of manufacturers, including cameras, lenses, lighting products, machine vision systems, and its own customized solutions.	**Revenue at 900 million yuan, net profit at 71 million yuan**
OPT	Established in 2006, one of the earlier enterprises in China to engage in machine vision. Its machine vision products have been widely used in various high-end equipment, serving many industries such as 3C electronics, new energy, semiconductors and some scientific research and teaching, and have been recognized by Apple, Omron, Amphenol, Hans Laser and other enterprises.	**Revenue at 875 million yuan, net profit at 303 million yuan**
China Daheng	Established in 1987, now the holding subsidiary of Daheng Technology. In terms of machine vision components, it has cooperation with many international famous brands and is their agent sales channel in China. Meanwhile, China Daheng also provides machine vision-oriented inspection equipment, with competitive advantages in printing, textile and other industries.	**Revenues at 780 million yuan**

Hikvision is expanding into industrial machine vision via Hikrobot, which is based on Hikvision's traditional security imaging and analysis technology
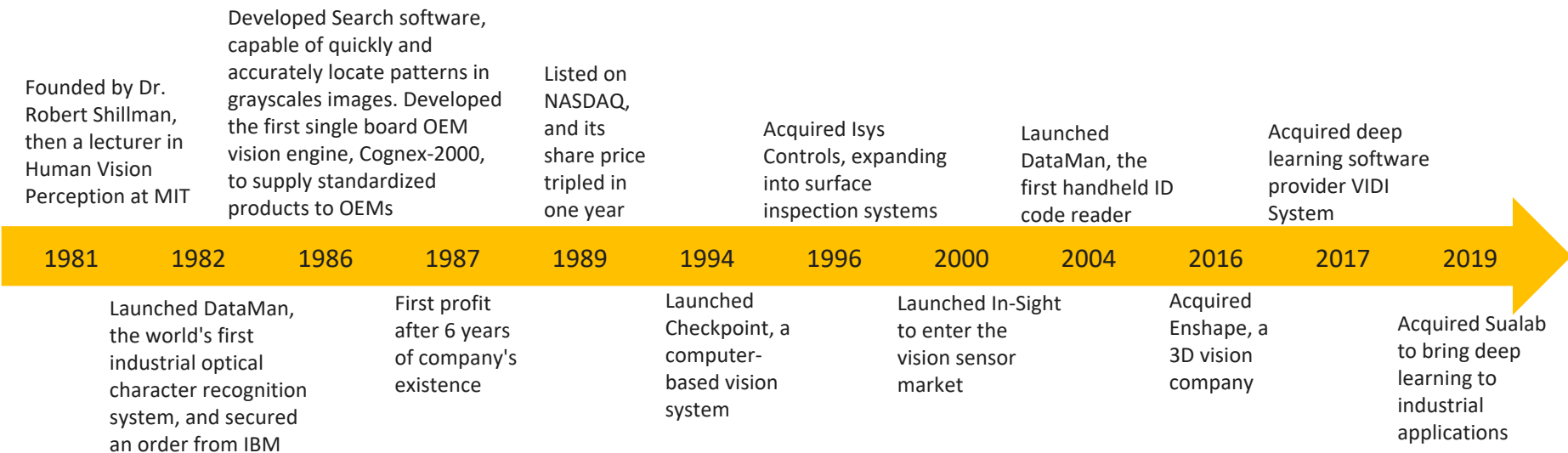
HIKROBOT, Hikvision's new innovative business, includes two major segments: mobile robotics and machine vision. The new business has doubled its YoY annual growth rate in 2021 by achieving a 2021 revenue of over 2.7 billion yuan. Based on ongoing expansion and optimization of its machine vision products, HIKROBOT has gradually built three new product lines: 2D vision product line, intelligent ID product line, and 3D vision product line. By using the VM (Vision Master) algorithm software platform, HIKROBOT has also worked with strategic partners in developing solutions to meet the needs of various industrial scenarios.

Industry applications

| High precision measurement | High precision guide positioning | AI defect detection | ID/OCR recognition | 3D measurement positioning | 3D defect detection |

Software system

VM algorithm platform

3D vision application platform

Hardware products

Industrial camera | Industrial lens | Industrial acquisition card | Industrial light source | Smart camera | Smart vision controller | Smart code reader | RGBD stereo camera | High precision laser profilometer

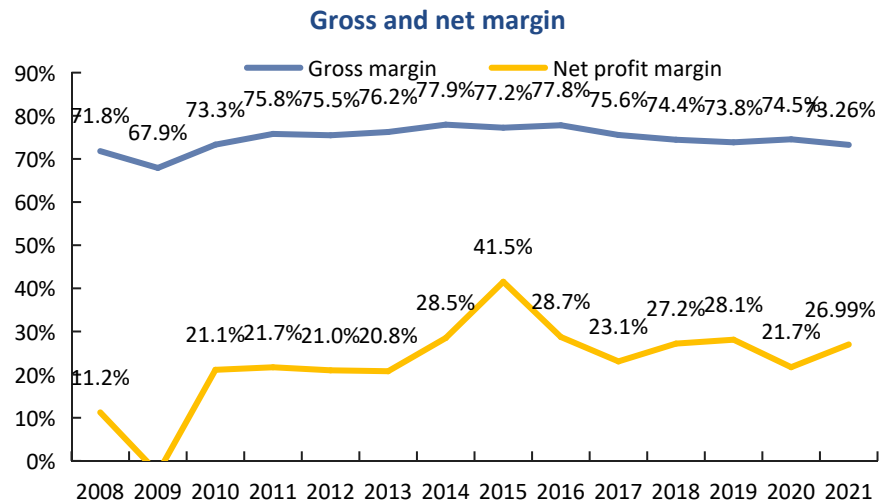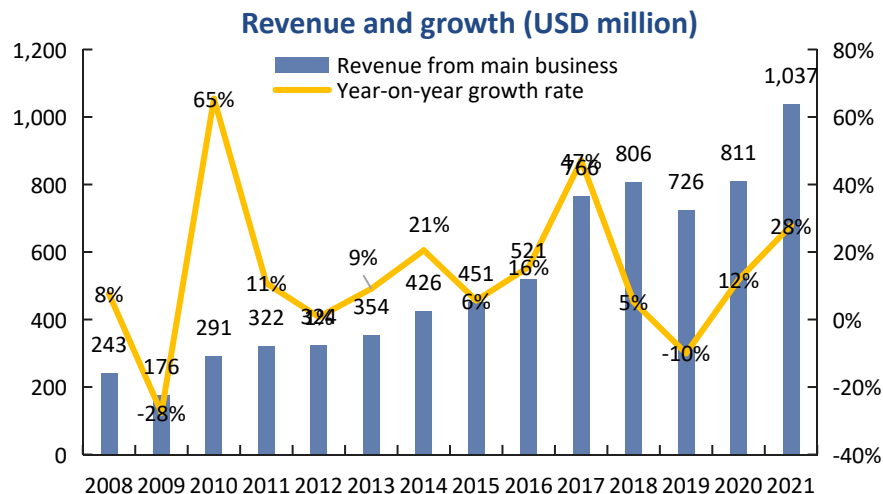2D standard product line | Smart ID product line | 3D product line

Cognex is the market leader and an industry benchmark for machine vision technology providers in the past forty years

- Cognex, a leading provider of machine vision systems, vision software, vision sensors, and industrial code readers for manufacturing automation, was founded in 1981 by Dr. Robert J. Shillman, then a lecturer in human vision perception at the Massachusetts Institute of Technology. The company manufactured its first vision system, DataMan, in 1982, the world's first industrial optical character recognition (OCR) system capable of reading, verifying and validating letters, numbers and symbols marked directly on parts and modules. The company made its first profit in 1987 and was publicly traded on NASDAQ in 1989.

- Cognex's business is divided into products and solutions: products include machine vision, code readers, deep learning systems, vision software,...etc., providing a wealth of standardized products, especially a complete series for traditional industrial fields. Industry coverage include airport baggage handling, automation equipment, automotive, consumer goods, electronics, food and beverage, life sciences, logistics, medical and pharmaceutical, solar energy, and tobacco.

Cognex's Brief Development History

1981	1982	1986	1987	1989	1994	1996	2000	2004	2016	2017	2019

Above the timeline:

- **1981:** Founded by Dr. Robert Shillman, then a lecturer in Human Vision Perception at MIT
- **1986:** Developed Search software, capable of quickly and accurately locate patterns in grayscales images. Developed the first single board OEM vision engine, Cognex-2000, to supply standardized products to OEMs
- **1989:** Listed on NASDAQ, and its share price tripled in one year
- **1996:** Acquired Isys Controls, expanding into surface inspection systems
- **2004:** Launched DataMan, the first handheld ID code reader
- **2017:** Acquired deep learning software provider VIDI System

Below the timeline:

- **1982:** Launched DataMan, the world's first industrial optical character recognition system, and secured an order from IBM
- **1987:** First profit after 6 years of company's existence
- **1994:** Launched Checkpoint, a computer-based vision system
- **2000:** Launched In-Sight to enter the vision sensor market
- **2016:** Acquired Enshape, a 3D vision company
- **2019:** Acquired Sualab to bring deep learning to industrial applications

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Cognex's sales revenue exceeded US$1 billion in 2021 amidst cyclical growth

Revenue and growth (USD million)

Legend: Revenue from main business; Year-on-year growth rate

Data points: 243, 176, 291, 322, 324, 354, 426, 451, 521, 766, 806, 726, 811, 1,037

Growth rates: 8%, -28%, 65%, 11%, 1%, 9%, 21%, 6%, 16%, 47%, 5%, -10%, 12%, 28%

Years: 2008–2021

Gross and net margin

Legend: Gross margin; Net profit margin

Gross margin: 71.8%, 67.9%, 73.3%, 75.8%, 75.5%, 76.2%, 77.9%, 77.2%, 77.8%, 75.6%, 74.4%, 73.8%, 74.5%, 73.26%

Net profit margin: 11.2%, 21.1%, 21.7%, 21.0%, 20.8%, 28.5%, 41.5%, 28.7%, 23.1%, 27.2%, 28.1%, 21.7%, 26.99%

Revenue share by region

	2021	2020	2019	2018	2017	2016	2015	2014
U.S.	42%	38%	38%	29%	24%	26%	27%	28%
Europe	24%	26%	31%	38%	43%	44%	44%	46%
Greater China	19%	21%	16%	16%	14%	12%	12%	9%
Other	15%	15%	15%	17%	19%	17%	17%	17%

Year-on-year revenue growth by region

	2021	2020	2019	2018	2017	2016	2015
U.S.	40%	12%	20%	29%	32%	14%	-1%
Europe	19%	-8%	-26%	-6%	42%	16%	2%
Greater China	19%	46%	-9%	16%	71%	17%	42%
Other	24%	17%	-25%	-5%	67%	15%	7%

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Keyence is a global automation equipment and machine vision market leader, with a business scale of 30+ billion yuan and a robust growth in the China market

Revenue (100mn yuan) and growth
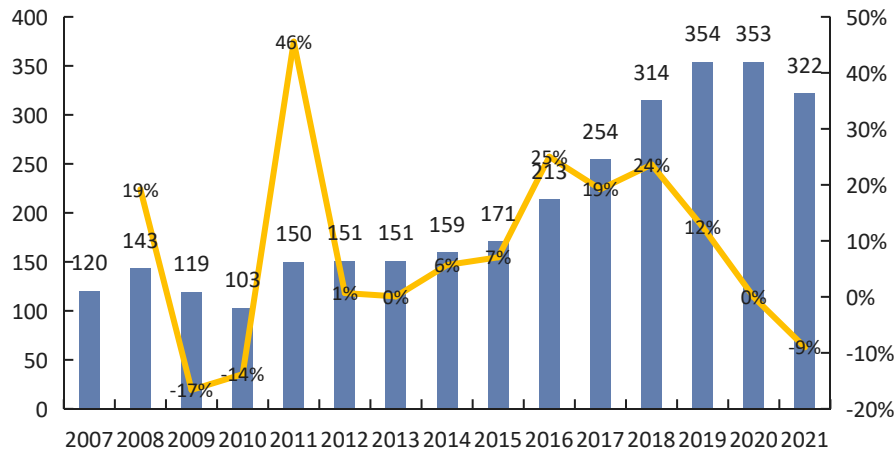
Net and gross margin
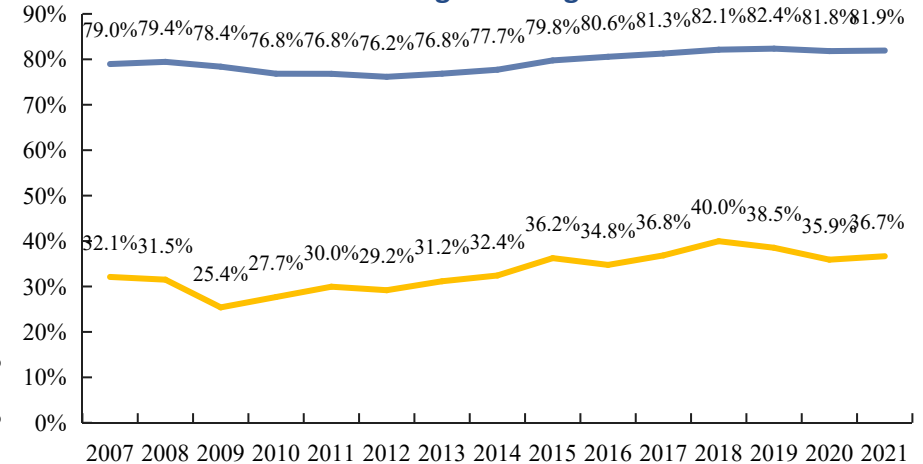
Revenue share by region

	2021	2020	2019	2018	2017	2016	2015	2014	2013
Other regions	25.6%	26.5%	26.5%	26.1%	24.3%	23.7%	31.1%	29.9%	26.9%
U.S.	14.4%	14.8%	14.8%	15.0%	14.9%	15.4%	19.5%	15.1%	12.6%
China	16.0%	11.6%	11.9%	12.2%	10.8%	11.1%	0.0%	0.0%	0.0%
Japan	44.0%	47.1%	46.9%	46.7%	50.0%	49.8%	49.4%	55.1%	60.5%

Year-on-year revenue growth by region

|	2021	2020	2019	2018	2017	2016	2015	2014
Other regions	-5.9%	-5.9%	13.1%	37.1%	11.6%	-13.5%	31.1%	35.1%
U.S.	-5.1%	-6.2%	10.3%	28.1%	5.6%	-10.6%	63.2%	45.3%
China	34.9%	-8.3%	8.2%	44.3%	5.9%			
Japan	-8.9%	-5.4%	11.7%	19.4%	9.1%	14.5%	13.1%	10.7%

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Valuation levels of Cognex and Keyence are rising in overseas capital markets

Keyence PE and share price growth trend (Share price base period April 27, 2012)

Market cap at USD101 billion in April '22

PE — Share Price Growth Rate
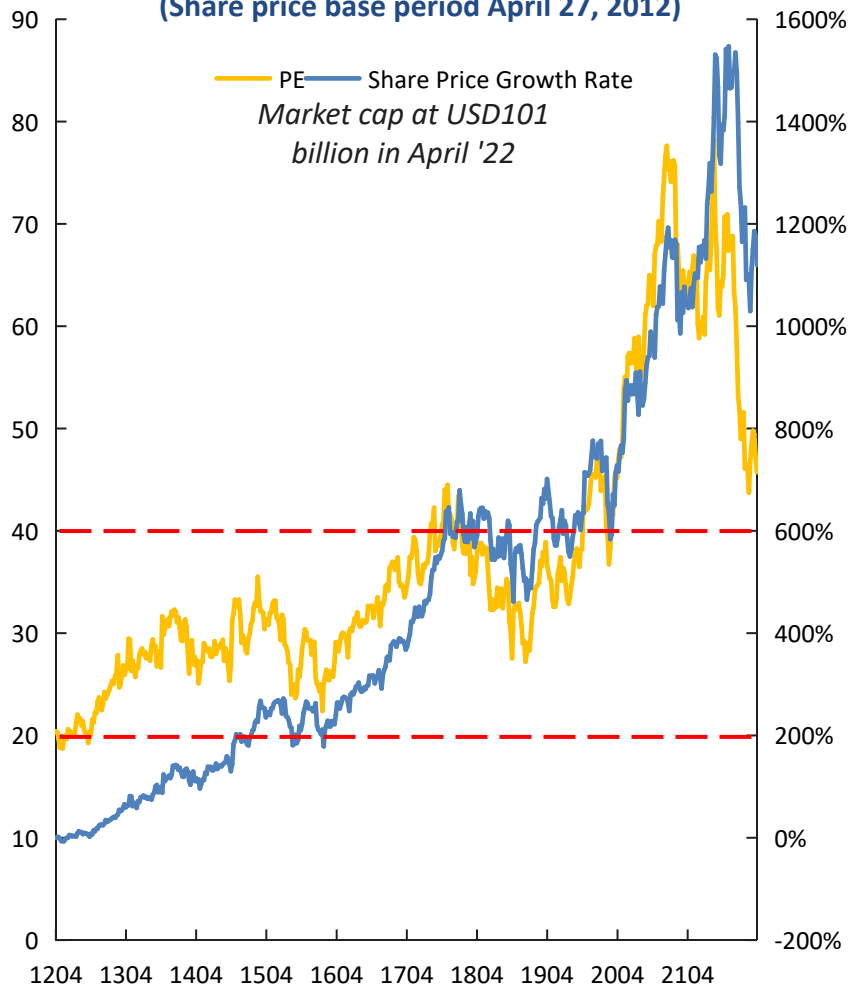
Cognex PE and share price growth trend (Share price base period April 27, 2012)

Market cap at USD12 billion in April '22

PE — Share Price Growth Rate
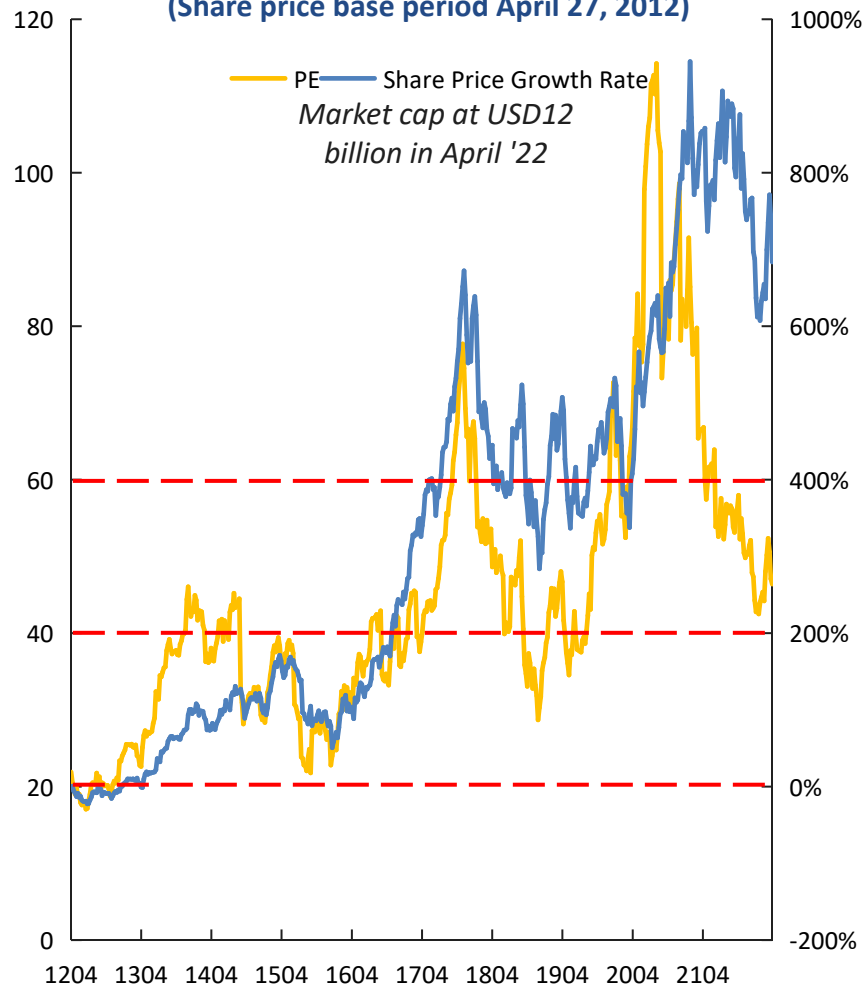
OPT's increasingly comprehensive machine vision applications and solutions are driving its sales of related hardware and software products

Types of machine vision solutions offered by OPT

Vision holisitic solution

Vision control system

Vision controller

SciVision Vision Development Kit
SciSmart Intelligent Vision Software

Imaging solution

Camera

Optical solution

Lens

Lighting solution

Light source

Light controller

Workpiece

OPT is also expanding from 3C consumer electronics to new energy, auto sector, and other emerging industries as it grows from customization to standardization

Industry Applications

- Industry solution standardization aiding replication and expansion; grasping emerging industry opportunities with advantages of being close to the industry chain and quick in service response

Expanding into emerging industries

| 3C Consumer Electronics | → | New Energy | → | Auto | → | Semiconductors |

60% of the total   *30% of the total*   *10% of the total*

Solutions

- Provide customized solutions relying on key clients and deepen industry understanding to accumulate know-how

Key Account Industry Solutions

Apple   CATL   Tesla

| Lighting solution | + | Imaging solution 6 | + | Optical solution | → | Holisitic solution |

Independent underlying product and technology system

Product Technology

- Rich product matrix, higher indeddpendence level; gradual product standardization

| Light source | + | Lens | + | Camera | + | Accessories | + | Industrial code reader |

| Light source controller | + | Vision Control System |

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OPT's 2021 sales breakdown of machine vision products: 1) 60% in 3C electronics applications, 2) 30% in new energy sector (i.e. for lithium battery production)

Downstream segment	2021 revenue share	Growth forecast	Development stage and logic
3C Consumer Electronics	60%	Stable growth. Slight growth for Apple in 2021, accelerated growth likely in 2022	(1) Amid more complex 3C product structure, increasingly higher requirements of the production line for production efficiency and processing accuracy, machine vision technology is moving from the assembly plant to the module plant. (2) The scope of cooperation between the company and Apple has been expanding from cell phones to iPad, headphones, watches and other production lines. (3) The solutions provided extend from imaging to holistic solutions as cooperations deepen.
New Energy	30%	Explosive growth. More than doubled growth in 2021, high growth in 2022	With more successful cases of machine vision applications in the battery production process that included defect detection, size measurement, and positioning, the company's products and technology have been recognized by industry leaders like CATL, BYD, and SVOLT. Surging demand for power batteries and energy storage batteries, as well as a push for new battery technologies such as 4680 and larger production capacity of lithium batteries in China are likely to amplify the growth of machine vision market.
Auto	10%	Potential to explode, large room for growth	Already a supplier of Tesla's supply chain system; new energy vehicle technology changes, along with the subsequently induced new production capacity-boosted demand potential is9 expected to explode.
Semiconductors		Large growth potential	Aggressive semiconductor push overseas

OPT has accumulated industry experience via a large number of quality customers, expanding its know-how to various industry-specific sectors

Company Customer Category
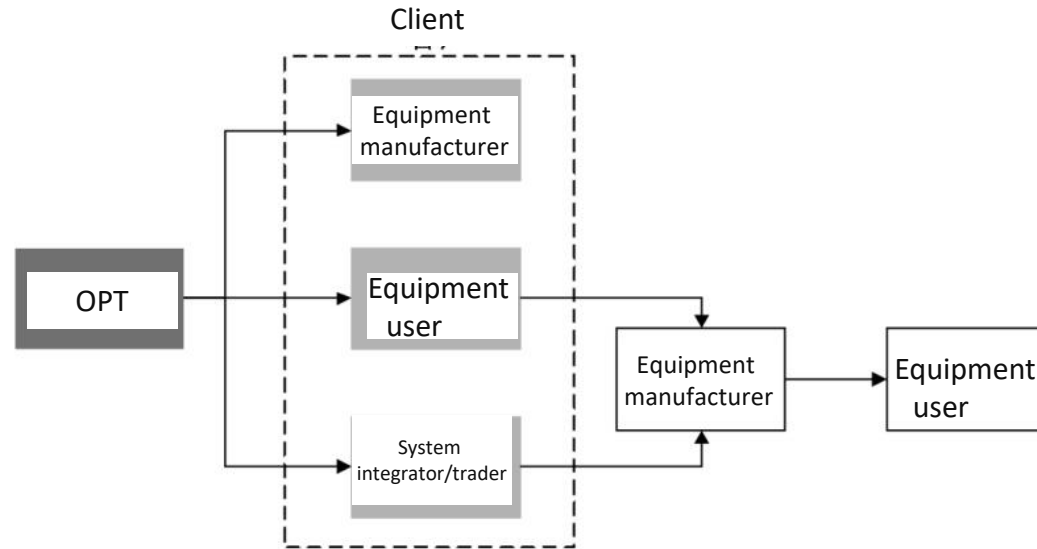
Downstream customer type	Customers
Equipment Manufacturers	Hans Laser, Secote, Victory Precision, DR Laser, Saejong, etc.Fengguang E1 Sihao E20X
Equipment users (including end customers)	**Apple**, Foxconn, Amphenol. **CATL (Lithium Batteries Manufacturing);** **Tesla**, Laird, Johnson Electric. **Nexperia**
System Integrators	Omron, Cognex

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Lithium battery expansion plan to 2025 will spur over 14 billion yuan in market demand for machine vision. OPT is a supplier of CATL for machine vision products

In 2021, China's power battery manufacturers installed capacity reached 154GWh with a year-on-year growth of 142.8%, accounting for nearly half of global capacity of 292GWh. Driven by market demand, lithium battery companies have been expanding production aggressively, including CATL, BYD, CALB, SVOLT, Gotion High-Tech, EVE, Envision AESC, Farasis Energy, Sunwoda, REPT and other companies, with a combined planned capacity of 3TWh by 2025.

The value of of vision products needed for 1GWh lithium battery production line construction will be 5 million yuan, and nearly 10 million yuan of vision-related components, according to our survey checks. By 2025, the total demand for machine vision from new production expansion is estimated at 14 billion yuan, and for related components is 28 billion yuan.

Major power battery manufacturers expansion plans in China

Home-grown power lithium battery manufacturers	Capacity planning to 2025
CATL	Planned capacity of over 670GWh
BYD	Planned capacity over 600GWh
CALB	Planned capacity 500GWh
SVOLT	Planned capacity 600GWh
Gotion High-tech	Planned capacity exceeds 300GWh

Global top15 companies by power battery installed capacity, 2021 (GWh)

Rank	Battery company	Installed capacity	Market share	Key models
1	CATL	93.68	32.1%	Model3, ModelY, Xpeng P7, Li ONE, Nio ES6, Nio EC6, Peugeot e-208
2	LGES	60.25	20.6%	Model 3, ModelY, VW ID3, Renault Zoe, Audi e-tron, Kona, Chevrolet Bolt, Porsche Taycan, I-Pace
3	Panasonic	46.64	16.0%	Tesla models, Corolla PHEV, IZOA E, Toyota C-HREV, Lexus ux300e
4	BYD	23.95	8.2%	All BYD models
5	SK On	14.36	4.9%	Kia NIRO, Kona EV, Kia Soul
6	Samsung SDI	9.66	3.3%	Skoda Enyaq iv, Fiat 500, VW up!
7	CALB	8.60	2.9%	AionS AionY, Changan Eado, BenBen E-Star, AionV, Hongguang Mini EV
8	Gotion High-tech	7.13	2.4%	Hongguang MINI EV, SOL E10X, Chery eQ1, Leap T03, BenBen E-Star, Geometry EX3, Ora Hao Mao, WM E5
9	Envision AESC	4,13	1.4%	Leaf, NV200, Outlander
10	Farasis Energy	2.91	1.0%	AionV, AionS, BAIC EC5, Bestune B30
11	SVOLT	2.42	0.8%	Ora Hao Mao, Ora R1, Ora R2
12	EVE	2.26	0.8%	Xpeng P7, Xpeng G3
13	Sunwoda	2.22	0.8%	Spring Electric EV, JOYEAR S50EV
14	REPT	1.78	0.6%	WM EX5, WM W6
15	Lishen	1.58	0.5%	Fengon E1, SOL E20X
	Others	10.55	3.6%	
	Total	292.13	100%	

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Note: CATL includes joint venture data, BYD includes FinDreams Battery
Source: GGII

OPT's vast holistic solution repertoire greatly increased the company's value

Sales and percentage changes by solution type (10,000 yuan)

Item	Jan.-June 2020		2019		2018		2017	
	Amount	%	Amount	%	Amount	%	Amount	%
Sales driven by solution	22447.11	93.41%	49251.49	93.89%	39238.24	92.96%	27936.33	92.33%
1) Hardware Solution	15461.22	64.34%	35756.85	68.17%	28868.01	68.39%	20812.32	68.78%
Lighting solutions	4504.43	18.74%	13013.11	24.81%	11567.35	27.40%	7769.78	25.68%
Optical Solutions	8474.61	35.27%	19528.16	37.23%	13359.73	31.65%	9190.69	30.37%
Imaging Solutions	2482.18	10.33%	3215.58	6.13%	3940.93	9.34%	3851.85	12.73%
2) Holisitic solution	**6985.89**	**29.07%**	**13494.63**	**25.73%**	**10370.23**	**24.57%**	**7124.00**	**23.54%**
Individual product sales	1583.98	6.59%	3203.32	6.11%	2971.28	7.04%	2322.16	7.67%
Total	24031.09	100.00%	52454.81	100.00%	42209.52	100.00%	30258.49	100.00%

- **The holisitic solution share further increased to 40% in 2021 and 50% in 1Q22.**

OPT has added new sales growth from its lens, camera, vision control system, and accessory products on top of its still growing light source related products

Category	Main Products
Light source	A total of 45 different product categories, nearly 1,000 standardized products, and more than 30,000 non-standard customized solutions; along with a rapid response capability of customizing light sources within 3 working days.
Lens	Own lens products mainly include fixed-focus lenses and line-scan lenses. Among them, fixed-focus lenses include 2, 5, 10 megapixel series and Cobra series, which are compatible with mainstream cameras; line-scan lenses include Coloretto, Hawk and Grampus series. Other lens products, such as telecentric lenses, are purchased externally and sold according to the demand of customer solutions.
Camera category	Industry specific know-how has been accumulated, laying the foundation for the development of its own camera. In 2019, a newly developed camera product with independent intellectual property was successfully launched on the market, with other new models still under R&D.
Light source controller	DPH strobe overdrive, DPA normal to high power current series, DPA current for spot lights, DPM mini current digital controllers, APA high power, current for spot lights analog controllers, AP analog voltage digital controller, APM mini analog voltage controller.
Vision Control System	SciVision software development kit, SciSmart intelligent vision software, and vision controller hardware.

Changes in sales breakdown (100mn yuan)
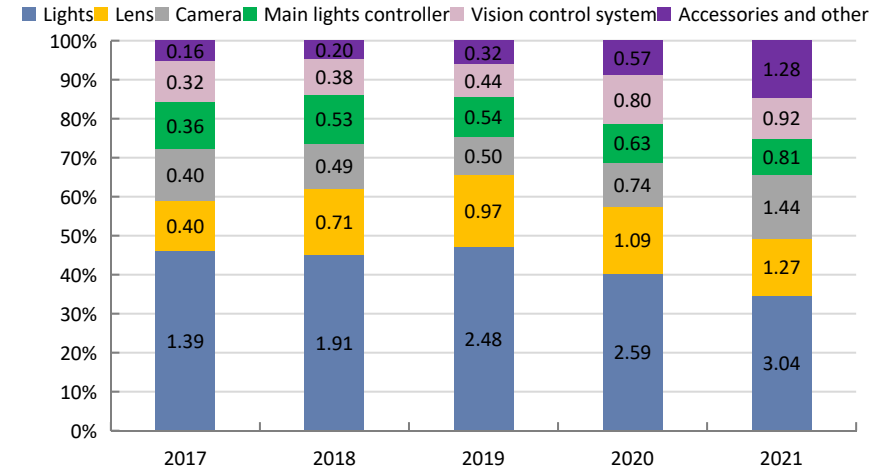
Gross margin of main business products

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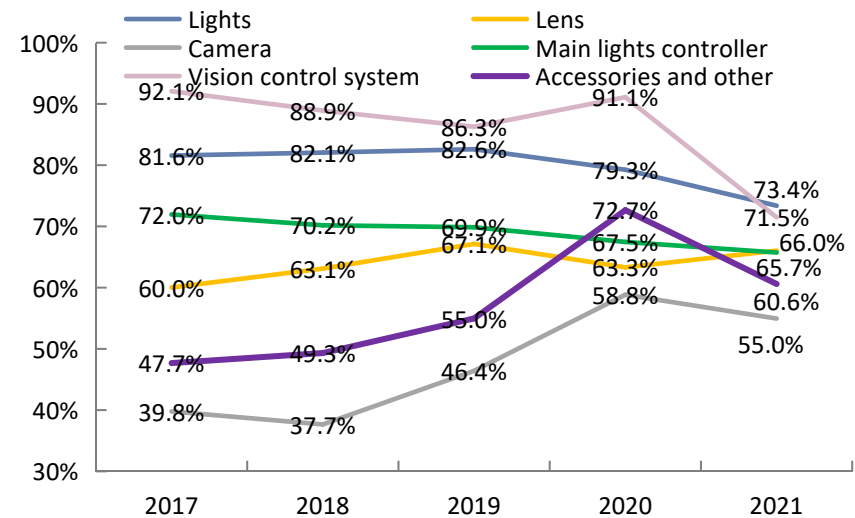
OPT's earlier machine vision core component products and technologies are gradually becoming matured independent product lines
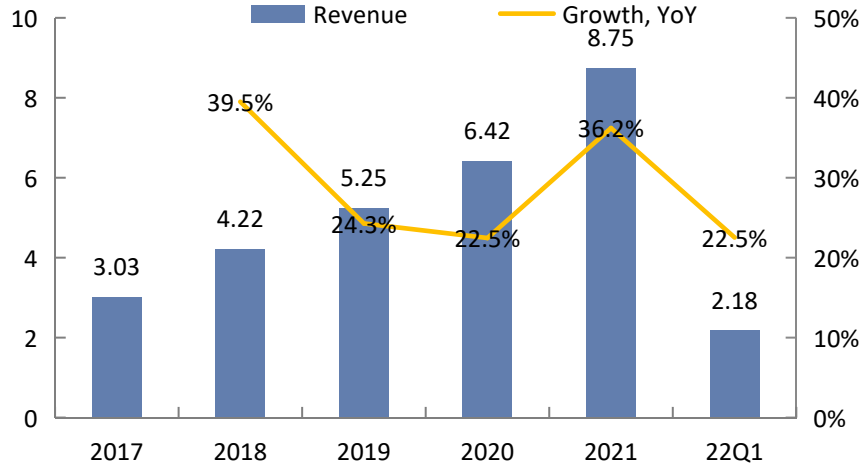
- In the early stage, the company grew from its light source products to other machine vision products and components.

- In 2021, industrial code reader, 3D laser sensor and deep learning products have been tested by many customers and generated large sales orders.
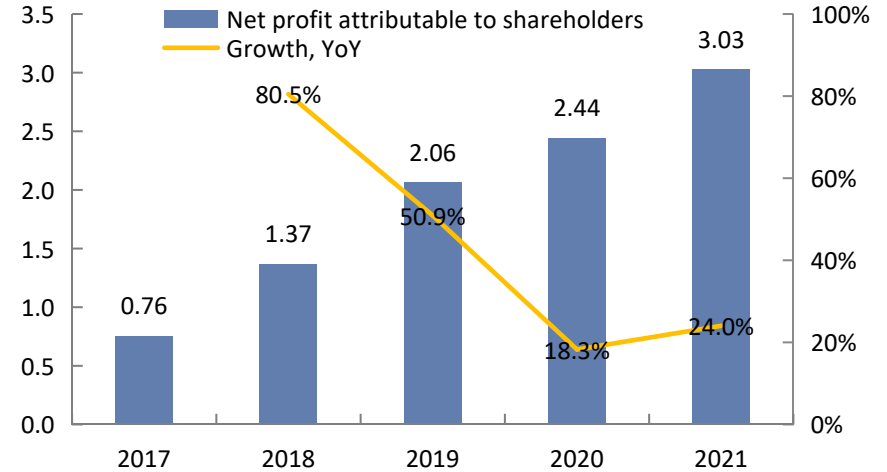
	Light source	Light controller	Lens	Vision controller	SciSmart SciVision	Camera
2020	Launched RGB tricolor linear and quasi-linear light source	Launched mini high power digital constant current controller series	Launched 1.1 series fixed-focus lens	Launched 2nd-generation Q2 series vision controller	Launched SciSmart 3.0	10-gigabit network line array industrial camera
2019		Launched first generation DPA6024E series products		Launched first generation EVC series vision controller	Launched SciVsion 3.0	First launched camera product
2018	Product line upgraded and integrated to 38 product categories	Launched 2nd generation DPA2024E series products	Launched first generation line scan lens	Launched first generation X series vision controller		Launched camera product R&D
2017		Launched second generation DPH20048E series products			Launched SciVision 2.0	
2016	Product line expanded to 45 product categories					
2015		Launched first generation DPH2004 series products	Launched first generation fixed focus lenses	Launched first generation Q series vision controllers	Launched SciVision 1.0	
2014		Launched first generation DPA1024 series products	R&D and production layout of lenses			
2013						
2012		Launched first generation DPA6024 series products			Launched SciSmart 2.0	
2011	Product line dxpanded to 25 product categories					

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OPT has been able to sustain its growth momentum by being on track to reap the benefits of its various heavily invested new businesses (i.e. in new energy sector)
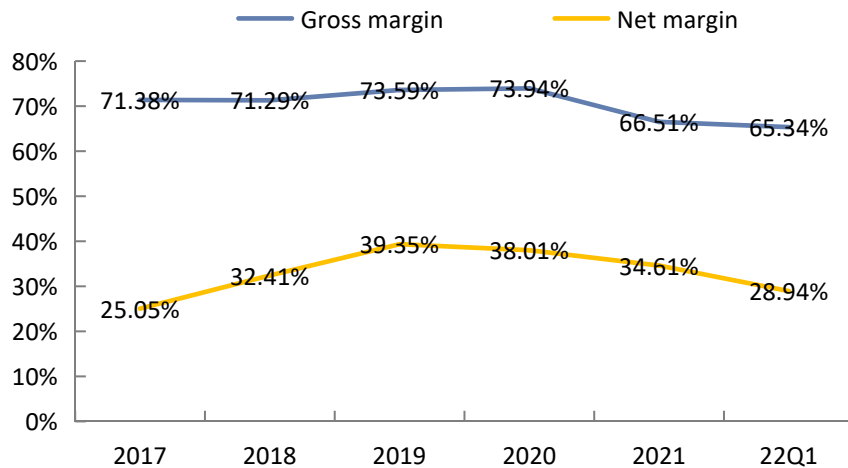
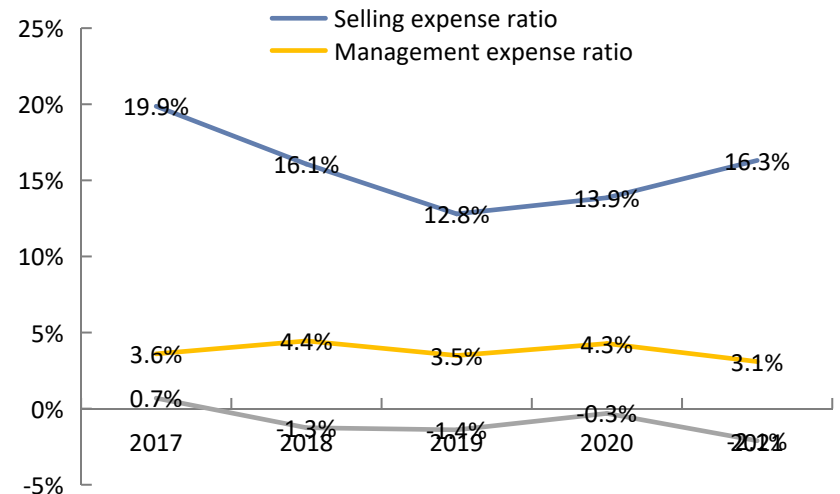### Company's total revenue size and growth (100mn yuan)

Revenue — Growth, YoY

2017: 3.03
2018: 4.22, 39.5%
2019: 5.25, 24.3%
2020: 6.42, 22.5%
2021: 8.75, 36.2%
22Q1: 2.18, 22.5%

Changes in company net profit (100mn yuan)*

Net profit attributable to shareholders — Growth, YoY

2017: 0.76
2018: 1.37, 80.5%
2019: 2.06, 50.9%
2020: 2.44, 18.3%
2021: 3.03, 24.0%

Changes in company profitability

Gross margin — Net margin

Gross margin: 71.38% (2017), 71.29% (2018), 73.59% (2019), 73.94% (2020), 66.51% (2021), 65.34% (22Q1)
Net margin: 25.05% (2017), 32.41% (2018), 39.35% (2019), 38.01% (2020), 34.61% (2021), 28.94% (22Q1)

Changes in company expense ratio

Selling expense ratio — Management expense ratio

Selling expense ratio: 19.9% (2017), 16.1% (2018), 12.8% (2019), 13.9% (2020), 16.3% (2021)
Management expense ratio: 3.6%, 4.4%, 3.5%, 4.3%, 3.1%
0.7%, -1.3%, -1.4%, -0.3%, -2.1%

- Excluding the effect of share-based payment expenses, net profit attributable to shareholders reached 72 million yuan, or 15% growth year-on-year.

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Source: Wind. 24

OPT's new energy business is experiencing explosive growth to bring about better operational efficiency, growth, and profitability for the company
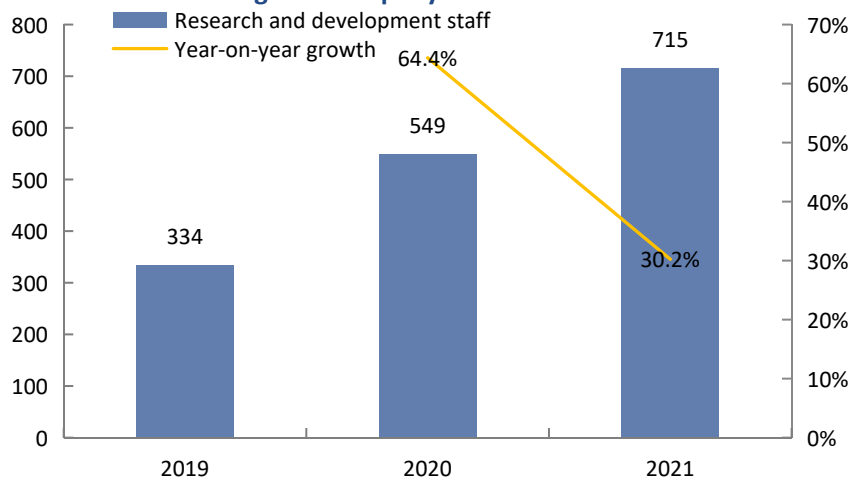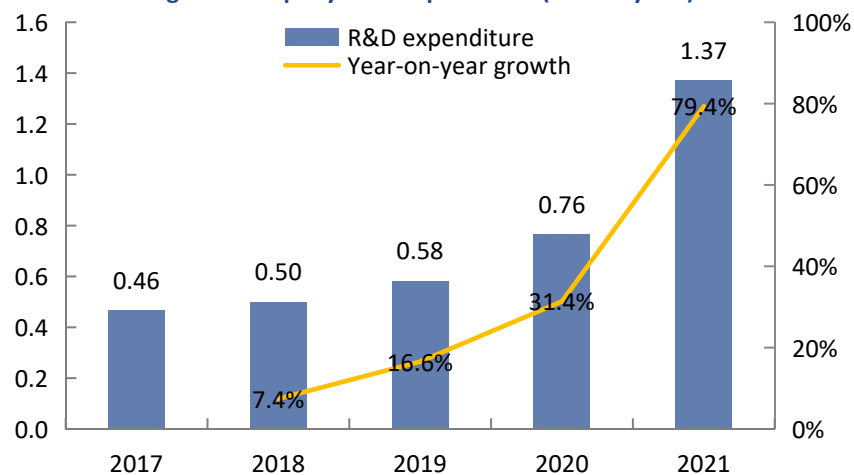
Changes in total company headcount
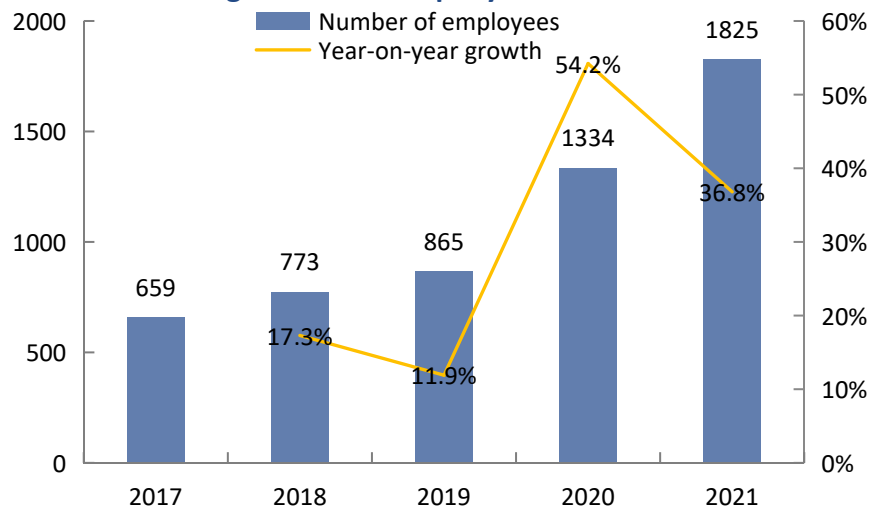
Changes in company efficiency per capita (10,000 yuan)
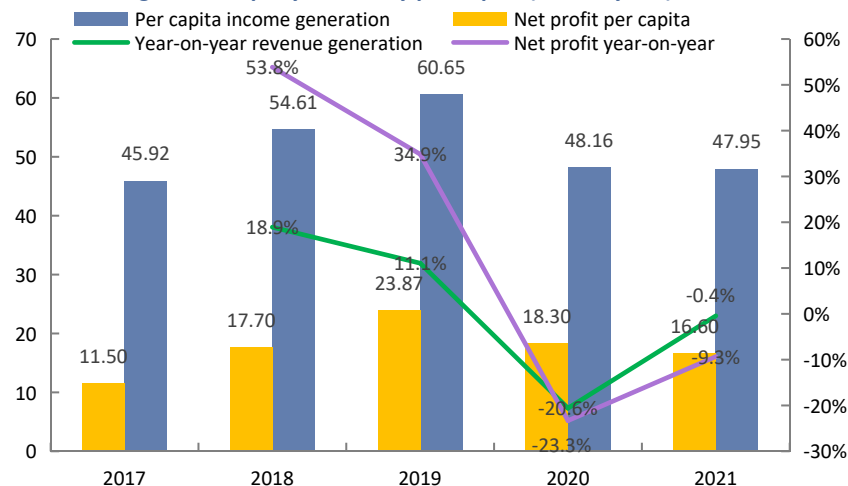
Changes in company R&D staff

Changes in company R&D expenditure (100mn yuan)

OPT's 16 years of deep farming has amplified its business scope from light source hardware to being China's leading provider of machine vision system

Founded in 2006, Aopute (OPT) follows the development path of 1) initially focusing on light source and light controller, which are prerequisites for a machine vision system in light related applications; 2) next, the company provided customers with solutions that combined with other machine vision components; 3) finally, the company established a relatively comprehensive product line portfolio with independent intellectual property rights and continuing to improve and optimize company products by its new product R&D achievements in vision control system, lenses, cameras and other machine vision components.

OPT company history

The company was established and launched the first generation of light source and light source controller products

First unveiled light source controller with automatic load detection technology; obtained RoHS certification and CE certification

Launched SciSmart 2.0, the first generation DPA6024 series and SciVision vision development kit; launched waterproof light source

| 2006 | 2009 | 2010 | 2012 | 2013 |

Launched SciSmart 1.0 for the first time, becoming a complete imaging solution provider for machine vision; received "National High-tech Enterprise" award for the first time

Full product upgrades, the standard light source product line expanded to 25 types

Launched the first generation of DPH2004 series products, the first generation of fixed-focus products, the first generation of Q series vision controller and SciVision 1.0; launched point, line, and surface multi-type high energy UV curing light source

Launched the second generation DPH20048E series and SciVision 2.0

Introduced RGB tricolor line light and quasi-linear light, mini high power digital constant current type series controller, 1.1 series fixed-focus lens, second generation Q2 series vision controller, SciSmart 3.0 and 10GbE line array industrial camera

| 2014 | 2015 | 2017 | 2018 | 2019 | 2020 |

Launched the first generation of DPA1024 series and laid out the development and production of lenses
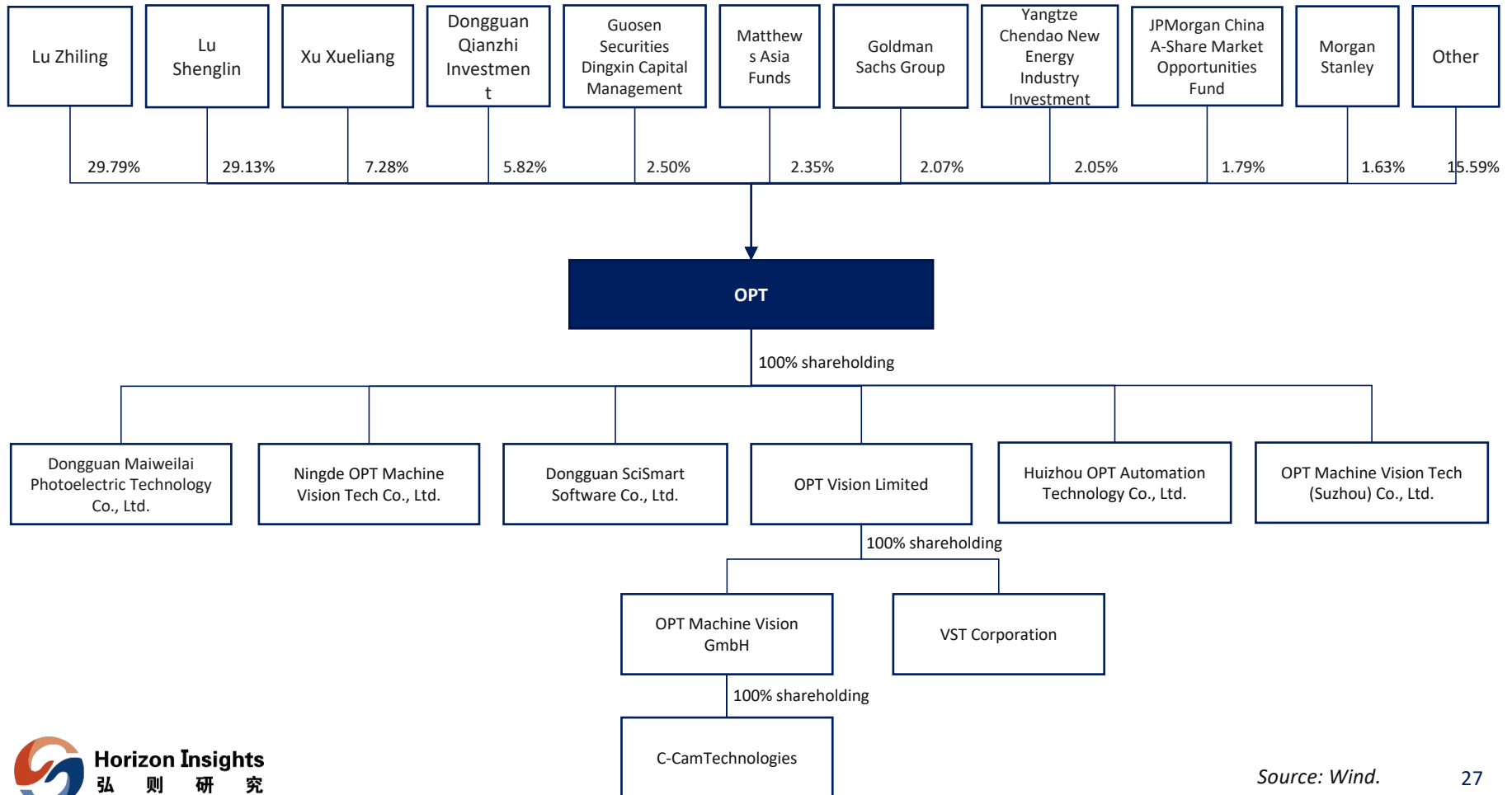
Product line upgraded and integrated into 38 series; launched the second generation DPA2024E series, the first generation of line scan lens, the first generation of X series vision controller and the business layout of camera product development9*

Launched the first generation of the DPA6024E series, the first generation of the EVC series vision controllers, SciVision 3.0 and its first camera products.

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OPT's Company Shareholding Structure

The top two shareholders are the founding brothers, Lu Zhilin and Lu Shenglin, holding 29.79% and 29.13% of company shares, respectively. Mr. Xu Xueliang and Qianzhi Investment are acting in concert with the company. Mr. Lu Shenglin is the chairman and deputy general manager, and is also one of the core R&D technicians of the company. Mr. Lu Zhilin is the general manager and a director of the board of directors.

Company shareholding structure chart (2021)

Lu Zhiling	Lu Shenglin	Xu Xueliang	Dongguan Qianzhi Investment	Guosen Securities Dingxin Capital Management	Matthews Asia Funds	Goldman Sachs Group	Yangtze Chendao New Energy Industry Investment	JPMorgan China A-Share Market Opportunities Fund	Morgan Stanley	Other
29.79%	29.13%	7.28%	5.82%	2.50%	2.35%	2.07%	2.05%	1.79%	1.63%	15.59%

OPT

100% shareholding

- Dongguan Maiweilai Photoelectric Technology Co., Ltd.
- Ningde OPT Machine Vision Tech Co., Ltd.
- Dongguan SciSmart Software Co., Ltd.
- OPT Vision Limited
- Huizhou OPT Automation Technology Co., Ltd.
- OPT Machine Vision Tech (Suzhou) Co., Ltd.

100% shareholding

- OPT Machine Vision GmbH
- VST Corporation

100% shareholding

- C-CamTechnologies

Thank You!

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Horizon Insights is a leading independent research company based in Shanghai. We deliver to our institutional clients and corporate clients a broad offering of macro research, China related commodities research, and industry research including technology, healthcare, consumer goods and capital goods. We provide fundamental research service that uncovers relevant investment trends for our investors.

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