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Global Passenger Car Vision Industry Report, 2022

Sept.2022

1. The revenues of major Tier 1 suppliers in 2021 sustained growth, as they made comprehensive layout of automotive vision business.

Denso registered total sales JPY5.5 trillion in 2021, of which JPY1.4 trillion (6.6% YoY), or 24.6% of the total was contributed by Mobility Electronics Division that operates automotive vision products. Denso's existing products contain front-view mono/stereo cameras, surround-view cameras, electronic rear-view mirrors and DMS as well as camera/radar combinations and ADAS/autonomous driving solutions.

Bosch sold a total of EUR78.75 billion (equivalent to USD78.55 billion) in 2021, a year-on-year increase of 10.1%, of which the sales of Mobility Solutions, a business sector operating automotive vision products, rose by 8.3% to EUR45.3 billion, sweeping 57.5% of the total. At present Bosch's products include front-view mono/stereo cameras, rear-view mirrors, surround-view cameras, DMS and OMS, as well as ADAS/autonomous driving/automated parking solutions.

Hyundai Mobis' total sales jumped by 13.9% from a year earlier to KRW41,702.2 billion (equivalent to USD29.9 billion) in 2021, and Automotive System Solutions Division engaged in automotive vision products sold KRW11,591.1 billion, or 27.8% of the total. Hyundai Mobis' products cover front-view mono cameras, surround-view cameras, electronic rear-view mirrors, DMS, and OMS.

Sales/Revenue of Some Major Global Tier 1 Suppliers, 2021

Company	Sales/Revenue in 2021		Parent Division of Automotive Vision Products			
	Sales	YoY	Parent Division of Automotive Vision	Sales	% of the Total	YoY
Bosch	EUR78.75 bn	10.1%	Mobility Solutions	EUR45.3 bn	57.5%	8.3%
Aptiv	USD15.62 bn	19.5%	Advanced Safety and User Experience	USD4.06 bn	26%	13.5%
Continental	EUR31.86 bn	-5.6%	Automated Driving	EUR7.56 bn	24%	0.8%
ZF	EUR38.31 bn	17.5%	Electronics & ADAS	EUR1.84 bn	4.8%	17.9%
Hyundai Mobis	KRW41,702.2 bn	13.9%	Automotive System Solutions	KRW11,591.1 bn	27.8%	-
Ricoh	JPY1,682.07 bn	4.5%	Industrial Solutions	JPY110.79 bn	6.3%	1.8%

Source: Suppliers

2. Camera resolution becomes increasingly high, and the era of 8 megapixels is around the corner.

The upgrade of ADAS sensing functions requires higher camera resolution. Ordinary automotive cameras generally feature about 1.2 megapixels. As ADAS sensing function upgrade algorithms get improved, a higher camera resolution is required. 8MP cameras deliver a detection range 3 times longer than 1.2MP cameras. High resolution automotive cameras will become a megatrend.

As concerns upstream contact image sensor (CIS) suppliers, OmniVision OX08B40 has supported 8-megapixel cameras in 2019; ON Semiconductor AR0820AT rolled out in 2018 boasts 8.3 megapixels; based on the previous generation with 7.42 megapixels, Sony's next-generation image sensors will offer 8 megapixels.

As for camera suppliers, many of the cameras starting mass production in 2020 are 8-megapixel front-view cameras, including: 8MP front-view mono camera Aptiv introduced in 2021; 8MP front-view mono camera Continental began to spawn in 2020; Samsung's front-view mono/stereo/triple cameras with the maximum resolution up to 12 megapixels. In June 2022, Samsung announced that it will start providing cameras for most Tesla models from the next year.

Examples of 8MP Automotive Cameras and Image Sensors

Company	Product	Time
Samsung	Front view mono/stereo/triple	2022
Aptiv	Mono IFV410	Nov. 2021
Veoneer	Mono MVS5, stereo SVS4	2024 (estimated)
Continental	Mono MFC500	2020
MCNEX	Mono, stereo	Jan. 2020
Sony	IMX324/IMX424	Jan. 2017
OmniVision	OX08B40	Dec. 2019

3. 120-140dB HDR becomes widespread, and 140+dB HDR becomes a future trend.

High dynamic range (HDR) allows quick recognition of details in brightness and darkness in different lighting conditions, and enables accurate image capture. For example, a typical HDR scenario requires vehicles to recognize details in both brightness and darkness when exiting a tunnel, and at night to detect pedestrians in extreme darkness and fairly bright vehicle lights and LED signal lights.

At present, the dynamic range of automotive cameras often ranges at 120-140dB. 130-140dB HDR image sensors have been largely seen. One example is OX03C10, a 2.5MP ASIL-C image sensor introduced by OmniVision in 2020, which provides 140dB HDR and supports rearview cameras, surround view systems and electronic rearview mirrors among others.

140+dB HDR will become a future trend. For example, the 8MP image sensor announced by ON Semiconductor in May 2022 achieves 155 dB HDR, and features LED flicker mitigation (LFM) super exposure (SE) technology.

Examples of Automotive Cameras and Image Sensors Supporting 120-140+dB HDR

Company	Product	Time	HDR Related
ON Semiconductor	The latest product	May 2022	Achieve ten times better HDR LFM capabilities than the previous generation and up to 155 dB dynamic range
OmniVision	OX03C10	Jun. 2020	140 dB high dynamic range (HDR)
Samsung	ISOCELL Auto 4AC	Jun. 2021	120dB HDR, providing a clear view of roads regardless of lighting conditions

4. Leading Tier 1s work to deploy DMS/OMS, and vital sign detection function becomes a standard configuration for OMS.

The vital sign detection function is used for detecting children. Application of this feature is primarily pushed by regulations, policies and safety standards. For example, starting in 2023, Euro NCAP Child Presence Detection (CPD) requirement will be worth up to four points. This feature is required to detect a child's presence in the vehicle and alert the vehicle user or emergency services. The Hot Car Act of 2021 (proposed in 2019) the US published in May 2019 requires all new passenger motor vehicles to be equipped with a child safety alert system.

At present, the common vital sign monitoring solutions include camera, radar, ultrasonic, gravity sensor, and in-vehicle carbon dioxide concentration monitor. Through the lens of development trends, OMS camera and interior radar are the solutions most widely adopted by OEMs.

The camera-based vital sign detection uses a camera to directly recognize occupants in the car. The main technologies include structured light and AI cloud. The camera is often installed at the top center of cockpit, or above center console display or interior rearview mirror. Models equipped with this solution like 2022 BMW iX adopt Aptiv's occupant perception platform where an OMS camera above interior rearview mirror enables vital sign detection in the cockpit.

For interior radar-based vital sign detection, the radar generally lies at B-pillars or rear doors. For example, the cockpit monitoring system to be unveiled by Continental in 2024 enables redundancy detection with interior radar on the top of cockpit and OMS camera above center console display, detecting adults, children, objects and pets. In terms of models with interior radar-enabled OMS, like Great Wall 2021 WEY VV6, after driver turns off car and locks doors, if detecting vital signs in the car with the radar built in driver's side B-pillar, the system will send vital sign information to driver's mobile phone.

Examples of OMS Products of Some Major Camera Suppliers, 2021-2024

Company	Release/SOP Time	Type of Solution	Specific Configuration
Bosch	2022	Single camera	Single OMS camera, installed above the interior rearview mirror
Continental	2024	Camera + radar	OMS camera installed above the center console display; 1 interior radar
ZF	2021	Single camera	OMS camera installed above the center console display
MCNEX	2021	Multiple cameras	DMS camera located above the dashboard; OMS camera located above the center console display
	2022	Multiple cameras	0.92MP OMS near-infrared camera; 0.77MP ToF camera
Faurecia	2021	Camera + Radar	DMS camera integrated in the dashboard display; 60GHz radar integrated in a rear door
Gentex	2022	Single camera	OMS camera integrated behind the interior rearview mirror lens
LG	2021	Multiple cameras	DMS camera integrated in the dashboard display; 2 IMS ToF cameras integrated on the front and rear row top of cockpit, respectively; DIMS (DMS+IMS) camera integrated in the interior rearview mirror

Source: ResearchInChina

Product Layout of Some Major Global Camera Suppliers

Company	Mono Camera	Multi-Camera	Surround View Camera	Rearview w Camera	Electronic Rearview Mirror	Interior Camera
Denso	Iterated in 2022	√	√		√	√
Bosch	√	√	√	√		√
Aptiv	Iterated in 2021					√
Panasonic Automotive			√	√	√	√
Veoneer	√	√				√
Continental	√	√	√	√	√	Mass-produced DMS in 2022
ZF	√	√	√			Launched OMS in 2021
MCNEX	√	Launched prism stereo camera in 2021	√	√	Launched a smart room mirror (SRM) in 2021	Launched 2 OMSs in 2021 and 2022
Magna	√		√		Launched an exterior electronic rearview mirror in 2022	Launched DMS in 2021
Valeo	√		√		√	
Faurecia				√	√	Launched 2 OMSs in 2021

Gentex					√	Launched OMS in 2021
First Sensor	√		√	√		√
Hyundai Mobis	√		√		√	√
LG	√	√	√			Launched OMS in 2021
Ricoh	√	√		√		
Hitachi Astemo		√				
Samsung	√	√	√	√	√	√

(Note: √ refers to products launched before 2021)

Source: ResearchInChina

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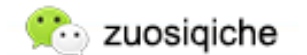
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