The information and statistics set out in this section and other sections of this document were extracted from different official government publications, available sources from public market research and other sources from independent suppliers, and from the independent industry report prepared by Frost & Sullivan. We engaged Frost & Sullivan to prepare the Frost & Sullivan Report. The information from official government sources has not been independently verified by us, the Joint Sponsors, **[REDACTED]***, any of the* **[REDACTED]***, any of their respective directors, supervisors, and advisors, or any other persons or parties involved in the* **[REDACTED]***, and no representation is given as to its accuracy. Accordingly, the information from official government sources contained herein may not be accurate.*

SOURCES OF INFORMATION

We engaged Frost & Sullivan, an independent market research consultant, to conduct an analysis of, and to prepare a report on the global 3D visual perception industry for the use in this document, which was commissioned by us for a fee of RMB500,000. In compiling and preparing the F&S Report, Frost & Sullivan adopted the following assumptions: (i) the social, economic and political conditions globally currently discussed will remain stable during the forecast period, (ii) global government policies on 3D visual perception industry will remain consistent during the forecast period, (iii) global 3D visual perception industry will be driven by the factors which are stated in the report in the forecast period. Except as otherwise noted, all of the data and forecasts contained in this section are derived from the F&S Report. The Frost & Sullivan Report has been prepared by Frost & Sullivan independently without any influence from us or other interested parties. Frost & Sullivan is an independent global consulting firm founded in 1961 in New York and its services include, among others, industry consulting, market strategic consulting and corporate training. Frost & Sullivan conducted (i) primary research, which involved discussing the status of the industry with certain leading industry participants, and interviews with industry experts on a best-effort basis to collect information in aiding in-depth analysis; and (ii) secondary research, which involved reviewing company reports, independent research reports and data based on its own research database.

BACKGROUND ANALYSIS OF THE PHYSICAL AI ERA

Artificial Intelligence is Evolving from the Virtual World to the Physical World

As general-purpose foundation models become increasingly mature and accelerate their scaled deployment, artificial intelligence is evolving from generative AI toward agentic AI and Physical AI. Its capabilities are expanding from understanding and generating digital content to task planning, tool use, and the perception of, decision-making in, and execution of actions in real-world environments. Meanwhile, as foundation models become increasingly integrated with intelligent terminal devices such as robots, the application of artificial intelligence is extending from the digital space into physical environments, including industrial manufacturing, logistics, commercial services, and daily life, creating higher requirements for environmental information collection, spatial understanding, and the ability to execute physical tasks.

As artificial intelligence evolves from the virtual world toward the physical world, the key challenges faced by the industry are no longer limited to computing power, models and simulated environments, but increasingly lie in how to accurately perceive complex 3D environments, continuously acquire high-quality real-world data covering actions and interactions, and reliably deploy model capabilities on intelligent terminal devices such as robots. Accordingly, 3D visual perception, data collection and deployment on intelligent terminal devices have become critical building blocks that connect AI models with the physical world and enable the continuous iteration and scaled deployment of Physical AI.

Three Pillars of Physical AI

Physical AI is primarily supported by three pillars: the **Physical Perception Layer**, the **Data and World Model Layer**, and the **Terminal Execution Layer**:

- **Physical Perception Layer: Acquiring and understanding information from the real world.** The physical perception layer comprises multi-modal perception devices, including 3D sensors, tactile and force sensors, and inertial sensors, together with depth calculation, data processing and multi-sensor fusion algorithms. These devices and algorithms convert real-world information into processable data for object identification, 3D understanding and environmental perception, providing the foundation for Physical AI decision-making and task execution.

- **Data and World Model Layer: Building the foundation for real-world representation, prediction and decision-making.** The data layer organizes, processes and transmits 3D, behavioral and interaction information collected from real-world scenarios, converting such information into data assets for model training, simulation validation and algorithm optimization. World models can learn from such data to represent object characteristics, 3D relationships, physical laws and environmental dynamics, and to predict potential state changes under different actions. These capabilities enable intelligent systems to plan tasks, select actions, evaluate outcomes, and continuously optimize model performance through newly collected data.

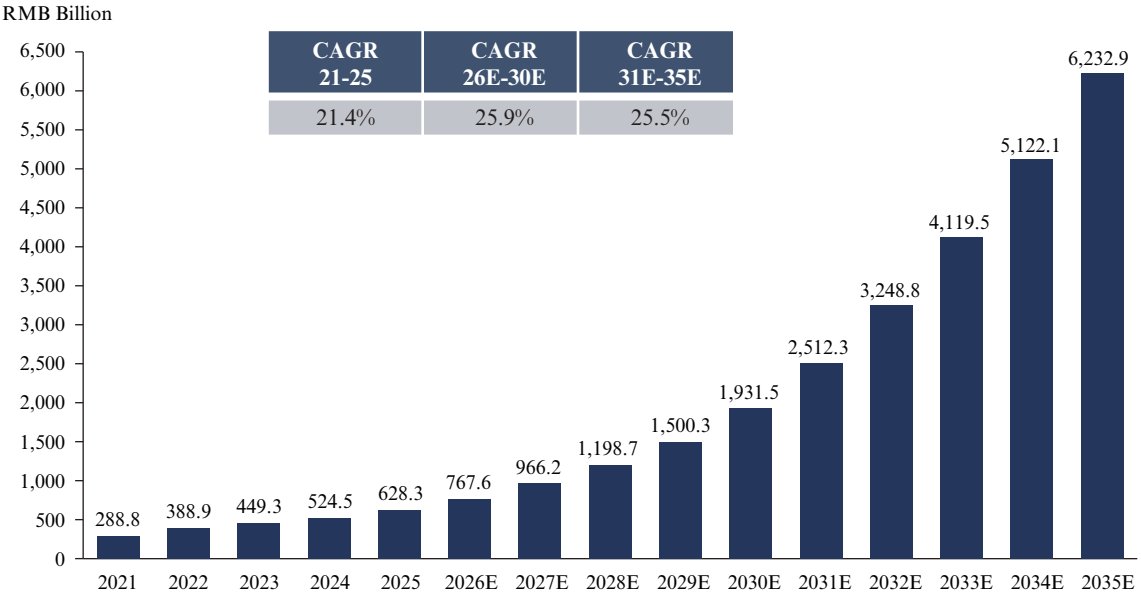
- **Terminal Execution Layer: Converting model decisions into physical actions.** The terminal execution layer mainly consists of commercial service robots, industrial robots, embodied intelligence robots and other intelligent terminal devices, which execute model-generated instructions through actions such as movement, grasping, assembly and human-robot interaction. Scaled deployment also requires engineering capabilities in product design, manufacturing, testing and delivery, supported by cooperation models including OEM, ODM and JDM.

Physical AI Market Size Analysis

With the accelerating adoption of robots and industrial automation equipment, Physical AI has continued to expand into manufacturing, logistics, commercial services and other physical-world scenarios. The global Physical AI market increased from approximately RMB288.8 billion in 2021 to approximately RMB628.3 billion in 2025, representing a CAGR of 21.4% during the period. In the future, as embodied intelligence robots accelerate commercialization and the application scope of commercial service robots, industrial robots and other products continues to expand, demand for robotic terminal devices, 3D perception devices and industrial automation equipment is expected to further increase. The global Physical AI market is expected to reach approximately RMB1,931.5 billion by 2030, representing a CAGR of 25.9% from 2026 to 2030, and further increase to approximately RMB6,232.9 billion by 2035.

The total addressable market ("**TAM**") for Physical AI refers to the theoretical upper limit of the market, assuming that relevant equipment achieves 100% penetration across all applicable scenarios. Based on estimates across four major scenarios, namely commercial services, industrial applications, embodied intelligence and logistics, the global TAM for Physical AI is estimated to exceed RMB65,000 billion.

Physical AI Market Size, Global, 2021–2035E



Source: Frost & Sullivan, China Robot Industry Alliance, National Data Administration

Key Value of 3D Visual Perception in Physical AI

- **A core perception gateway to the real world:** 2D vision captures projected images from specific viewpoints, without directly measuring depth or representing the full spatial structure of a scene. By contrast, 3D visual perception captures depth and geometry at real-world scale. By fusing observations from multiple viewpoints, it can reconstruct a spatial representation that can be viewed and analyzed from different angles, rather than being limited to the original capture viewpoints. This enables Physical AI systems to determine object positions, shapes, poses and motion, identify occlusion relationships and understand spatial layouts, supporting spatial understanding, path planning and action decisions in complex environments and enhancing robots' autonomous operation.

- **A high-quality data foundation for bridging virtual and physical environments:** 3D visual perception holistically and fully captures spatially consistent data on scene structures, object poses and interactions at real-world scale, supporting scene reconstruction, model training and simulation. These data enable real-world scenarios to inform virtual training, while simulation-trained models and policies can be deployed and tested on physical devices, facilitating real-world application.

- **A key enabler of complex task execution and continuous iteration:** 3D visual perception provides real-time depth, position and pose information for navigation, grasping, assembly and human-robot interaction, enabling robots to adapt their actions to environmental changes. Operational data can then be fed back into model training and algorithm optimization, creating a perception–execution–feedback cycle that advances Physical AI from single-task validation to multi-scenario applications and scaled deployment.

Evolution from Component Supply to System-Level Delivery Capabilities

As Physical AI applications progress from isolated validation to scaled deployment, customers' requirements are shifting from the performance of individual components toward

system-level stability, compatibility and delivery efficiency. Suppliers capable of integrating perception hardware, data collection and engineering delivery can coordinate these elements from the product design stage, reducing integration efforts and duplicated development, and shortening customers' product validation and mass-production cycles. At the same time, real-world data continuously generated by deployed terminal devices can feed back into perception algorithms and product iteration, forming a self-reinforcing cycle of continuous improvement. Against this backdrop, the expansion of perception vendors from component supply into integrated solutions and whole-device engineering services, together with deeper participation in customers' product definition and joint development, is becoming an important direction of industry competition.

ROBOT 3D VISUAL PERCEPTION MARKET ANALYSIS

Definition and Classification of Robot Perception

- **Robot perception is primarily categorized into visual perception, tactile perception and other perception modalities.**

Robot perception primarily refers to embodied perception products and solutions that are mounted on or integrated into the robot itself, form part of the robot's own perception system, and operate in real time with the robot to support functions such as autonomous movement, spatial understanding, obstacle avoidance, human-robot interaction and general manipulation. It excludes perception devices deployed independently from the robot, as well as industrial-grade perception devices fixed at workstations and primarily used for tasks such as workpiece positioning and inspection.

Based on the type of information perceived, robot perception includes visual perception, tactile perception and other perception modalities. Robot visual perception uses sensors and related algorithms to acquire and process information such as color, texture, shape, position, distance and spatial relationships of humans, objects and the surrounding environment. Tactile perception uses point-based, array-based, distributed electronic skin and visuotactile solutions to acquire information on contact force, pressure, deformation, vibration, slippage and temperature. Other sensing modalities include auditory sensing, temperature sensing and LiDAR.

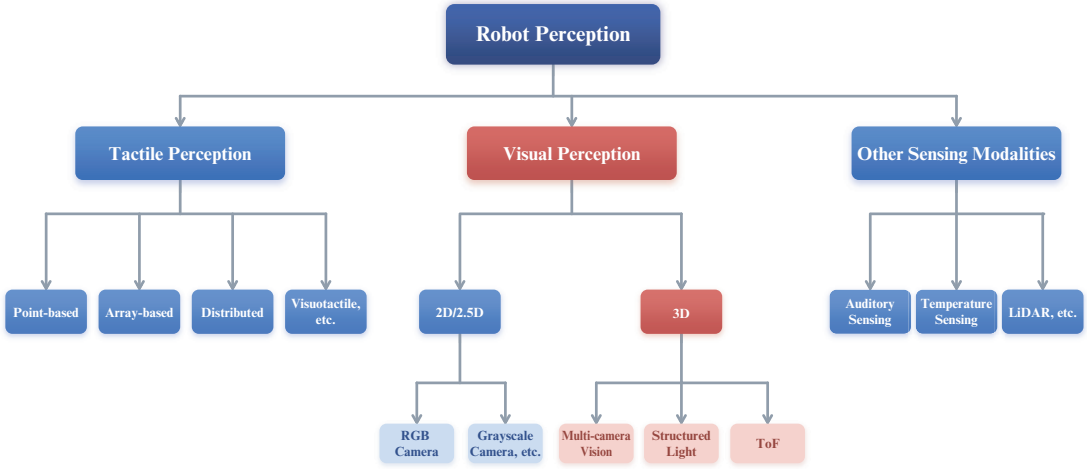
Compared with machine vision, which is primarily used at fixed workstations and in structured environments to perform tasks such as inspection, recognition and positioning of specific objects, robot visual perception needs to operate continuously in coordination with the robot in dynamic, multi-scenario environments and feed perception results in real time into positioning, planning and motion control. This enables robots to adjust paths, poses and actions in response to environmental changes, and to perform complex tasks involving motion control such as autonomous movement, obstacle avoidance, grasping and precise manipulation. Accordingly, robot visual perception places higher requirements on real-time performance, environmental adaptability and coordination with robotic motion-control systems.

- **Based on the spatial dimensions of the information acquired, visual perception can be further categorized into 2D/2.5D vision and 3D vision**

2D/2.5D vision primarily relies on imaging approaches such as monocular vision to acquire two-dimensional image information through RGB cameras, grayscale cameras, line-scan cameras, area-scan cameras and other imaging devices. In particular, 2D vision primarily captures two-dimensional image information such as color, texture and contours, and supports tasks including object detection, recognition, tracking and image segmentation. Building on two-dimensional images, 2.5D vision can further estimate information such as local depth, height or surface variations observed from a specific viewpoint using monocular vision algorithms and other methods. However, it generally does not directly generate a complete 3D spatial representation of objects and their surrounding environments, and can only be used for tasks such as surface inspection, height measurement and assisted localization.

3D visual perception further acquires 3D information on objects and their surrounding environments, including depth, distance, 3D coordinates, spatial structures and object poses, and develops an understanding of the spatial relationships between objects and their environments through depth calculation and spatial information analysis. Such information provides a basis for decision-making and motion control in robot functions such as, positioning and navigation, obstacle avoidance, motion planning, object grasping and precise manipulation, rather than merely capturing image information through cameras. Major technology pathways for 3D vision include stereo and multi-camera vision, structured light and time-of-flight ("**ToF**"). Stereo vision includes passive stereo vision, which uses two cameras under ambient light to derive depth through stereo matching and disparity calculation, and active stereo vision, which adds an active light source such as infrared speckle patterns to improve matching and depth calculation in low-texture or low-light environments. ToF primarily refers to ToF vision solutions based on depth cameras and imaging systems, including iToF and dToF, and excludes standalone LiDAR products.

Classification of Robot Perception



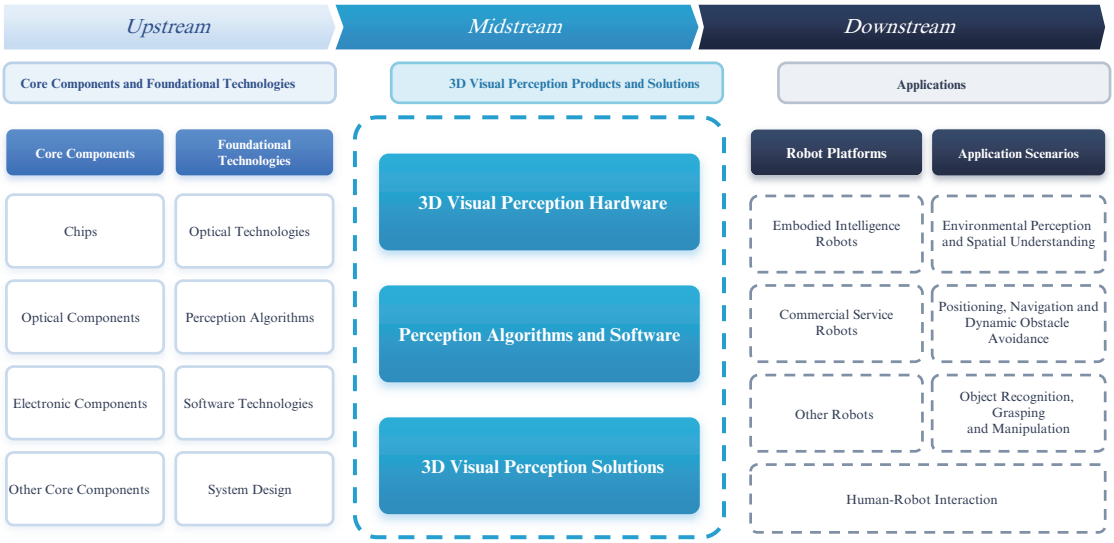
Source: Frost & Sullivan, China Robot Industry Alliance, International Federation of Robotics

Robot 3D Visual Perception Industry Value Chain Analysis

The robot 3D visual perception industry value chain comprises an upstream segment consisting of core components and foundational technologies, a midstream segment comprising 3D visual perception products and solutions, and a downstream segment comprising robotic platforms and applications. The midstream segment plays a critical role in bridging underlying technologies and end applications.

Midstream companies represented by **the Company** cover 3D visual perception hardware, perception algorithms and software, and related solutions, providing 3D visual perception capabilities for downstream robots and related applications.

Robot 3D Visual Perception Industry Value Chain



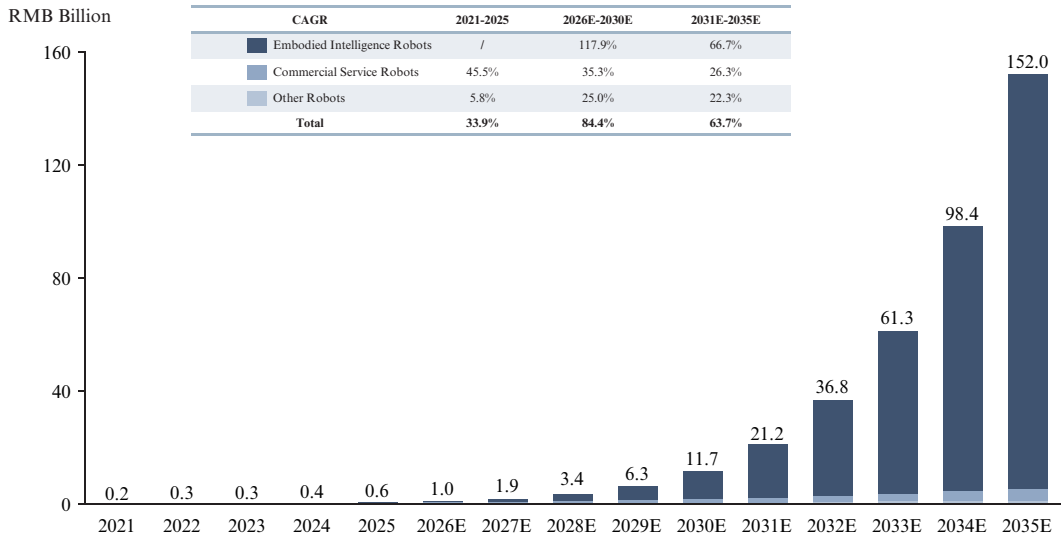
Source: Frost & Sullivan, China Academy of Information and Communications Technology, International Federation of Robotics

Robot 3D Visual Perception Market Size Analysis

As the scale of robot adoption expands, application scenarios become increasingly diverse, and requirements for environmental perception and autonomous operation continue to rise, the global robot 3D visual perception market has grown rapidly. The global robot 3D visual perception market increased from RMB0.2 billion in 2021 to RMB0.6 billion in 2025, representing a CAGR of 33.9%, and is expected to reach RMB11.7 billion by 2030, and RMB152.0 billion by 2035, driven by the scaled deployment of embodied intelligence robots and a broader range of application scenarios.

By market segment, the global 3D visual perception market for **embodied intelligence robots** was approximately RMB0.2 billion in 2025 and is expected to reach RMB9.9 billion by 2030 and RMB146.6 billion by 2035, driven by the commercialization and scaled deployment of embodied intelligence robots and rising demand for spatial understanding, environmental interaction and precise manipulation. The global market for **commercial service robots** reached approximately RMB0.3 billion in 2025 and is expected to increase to RMB1.3 billion by 2030 and RMB4.2 billion by 2035, supported by continued adoption across scenarios such as cleaning, delivery and reception. **Other robots**, mainly including logistics robots, special-purpose robots and robotic lawn mowers, generated a global 3D visual perception market of approximately RMB0.2 billion in 2025, which is expected to reach RMB0.4 billion by 2030 and RMB1.2 billion by 2035 as adoption expands into more complex scenarios.

Robot 3D Visual Perception Market Size, Global, 2021–2035E



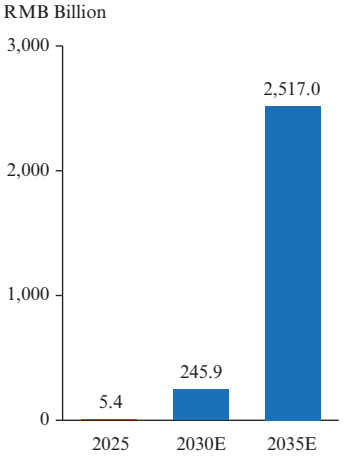
Global	2021	2022	2023	2024	2025	2026E	2027E	2028E	2029E	2030E	2031E	2032E	2033E	2034E	2035E
Robotic 3D Visual Perception	**0.2**	**0.3**	**0.3**	**0.4**	**0.6**	**1.0**	**1.9**	**3.4**	**6.3**	**11.7**	**21.2**	**36.8**	**61.3**	**98.4**	**152.0**
Embodied Intelligent Robots	\	\	**0.0**	**0.0**	**0.2**	**0.4**	**1.1**	**2.4**	**5.0**	**9.9**	**19.0**	**33.8**	**57.6**	**93.8**	**146.6**
Commercial Service Robots	**0.1**	**0.1**	**0.2**	**0.2**	**0.3**	**0.4**	**0.5**	**0.7**	**1.0**	**1.3**	**1.7**	**2.1**	**2.7**	**3.4**	**4.2**
Other Robots	**0.1**	**0.1**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.3**	**0.3**	**0.4**	**0.5**	**0.8**	**1.0**	**1.2**	**1.2**

Source: Frost & Sullivan, National Data Administration, International Federation of Robotics

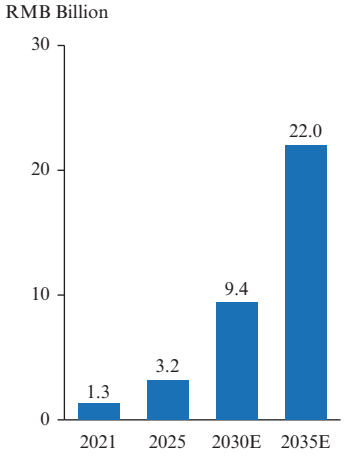
Analysis of Key Downstream Demand for Robot 3D Visual Perception

3D visual perception has been widely adopted across various types of robots and plays an important role in core functions such as environmental perception, spatial understanding, positioning and navigation, and precise manipulation. Embodied intelligence robots use 3D visual to acquire depth, position, pose and spatial-relationship information for autonomous navigation, object recognition, grasping, manipulation and human-robot interaction. Commercial service robots use 3D cameras for mapping, positioning, navigation, obstacle avoidance and interaction, while logistics robots use it to identify, locate and measure shelves, pallets, bins, goods and obstacles to support navigation, handling, picking, placing, loading and unloading. As robots become increasingly autonomous and their tasks more complex, and as downstream applications expand from individual scenarios into a broader range of complex, dynamic and unstructured environments, the breadth and depth of 3D visual perception applications and demand for its integration into robots are expected to further increase.

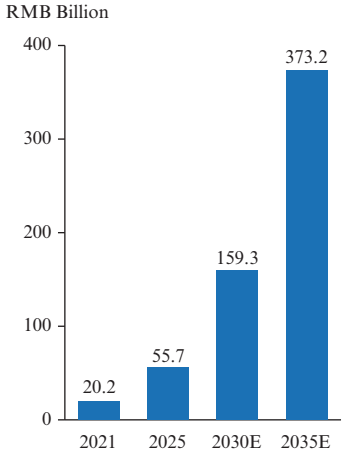
Embodied Intelligence Robot Market Size, Global, 2025, 2030E and 2035E



Commercial Service Robot Market Size, Global, 2021, 2025, 2030E and 2035E



Logistics Robot Market Size, Global, 2021, 2025, 2030E and 2035E



Source: Frost & Sullivan, National Data Administration, International Federation of Robotics

Market Drivers and Development Trends of Robot 3D Visual Perception

- **Continued expansion of the robot market is driving rapid growth in demand for 3D visual perception products.** As embodied intelligence robots and commercial service robots continue to grow rapidly, robot shipments and application scenarios continue to increase, driving demand for environmental perception, spatial understanding, navigation, obstacle avoidance and precise manipulation. This, in turn, is driving higher adoption and shipment volume of 3D visual perception products.

- **Increasing task complexity is driving higher deployment and value of 3D visual perception products per robot.** Robot applications are expanding from standardized and structured scenarios into more complex, dynamic and unstructured environments, requiring greater perception range, accuracy, real-time performance and spatial understanding. This is increasing the number of 3D visual perception products deployed on each robot, thereby raising the perception system value per robot.

- **Increasing adoption of multi-modal perception is enhancing robots' environmental understanding and interaction capabilities.** Robot 3D visual perception is evolving from reliance on visual information alone toward the coordinated use of multi-modal information across vision, tactile sensing, inertial sensing and other modalities. Integrating these data types enables robots to better understand spatial environments, object states and interaction processes, thereby improving perception stability, decision-making accuracy and task execution capabilities in complex scenarios.

- **Expanding applications of 3D visual perception into data collection, spatial modeling and simulation validation are forming a real-world data closed loop.** Beyond real-time perception and task execution by robots, 3D visual perception can also be used to capture spatial structures, object states and interaction information from the real world, with such data further applied to spatial modeling, model training and simulation validation. This enables real-world data to continuously feed into model training, algorithm optimization and terminal execution, gradually forming a real-world data closed loop.

Key Success Factors for Robot 3D Visual Perception Companies

- **Full-stack technology capabilities and a multi-pathway product portfolio support diverse robotic needs.** Robot 3D visual perception involves multiple technologies across optics, chips, algorithms, software and systems engineering. As robot form factors and application scenarios vary in perception range, accuracy, power consumption, interface and cost, companies need comprehensive R&D capabilities and a product portfolio covering major technology pathways, including stereo and multi-camera vision, structured light and ToF, to continuously address diverse market needs.

- **Scaled mass-production and quality-control capabilities are critical to ensuring stable product delivery.** 3D visual perception products typically involve multiple processes, including design, calibration, testing and quality control, and are required to maintain a high degree of stability, reliability and consistency in complex environments. Companies with mature mass-production systems and quality-management capabilities are better positioned to meet robot customers' requirements for large-volume and stable long-term delivery.

- **Ecosystem compatibility and scenario-specific delivery capabilities determine the efficiency of product deployment across different robotic platforms.** Robot manufacturers differ in terms of hardware platforms, operating systems, software interfaces and application requirements. 3D visual perception companies therefore need strong platform compatibility, hardware and software adaptation, and customized development to shorten customers' development and product introduction cycles.

Overview of the Competitive Landscape of the Robot 3D Visual Perception Industry

Participants in the global robot 3D visual perception market mainly include comprehensive providers with capabilities across multiple technology pathways and scaled mass production, and specialized providers focusing on specific technologies or application scenarios. As applications such as embodied intelligence robots, commercial service robots and industrial robots continue to expand, competition has extended beyond individual sensor performance to comprehensive capabilities in technology, product portfolio, customer coverage, scaled delivery and ecosystem compatibility. Leading players typically offer diversified technologies including stereo vision, structured light and ToF, supported by accumulated experience in product development, mass production and scenario adaptation, while specialized players differentiate through specific technologies, product forms or application scenarios. As robot applications become more complex and scaled deployment increases, companies with full-stack capabilities, broader product portfolios and large-scale delivery experience are expected to be better positioned to compete.

Ranking and Market Share of Robot 3D Visual Perception Companies

The global robot 3D visual perception market is relatively concentrated, with leading players accounting for a significant share of the market. Unlike ordinary cameras that primarily perform image capture and data transmission, robot 3D visual perception typically incorporates capabilities such as depth perception and data processing, enabling the real-time processing and analysis of captured visual data and converting such data into information that can support robots in environmental understanding, spatial assessment and task decision-making, thereby enabling the execution of more complex robotic tasks. Leading players have secured significant market shares through their long-term accumulation of capabilities in 3D visual perception technologies, product performance, scaled delivery and customer resources. In 2025, in terms of revenue, the top five players in the global robot 3D visual perception market collectively accounted for 71.7% of the market, among which **the Company** ranked first with a market share of 29.0%.

Ranking and Market Share of Robot 3D Visual Perception Companies, by Revenue, Global, 2025

Ranking	Company Name	Market Share
		(%)
1.	**The Company**	**29.0%**
2.	Company A	27.9%
3.	Company B	6.6%
4.	Company C	6.6%
5.	Company D	1.6%

Source: Frost & Sullivan, China Robot Industry Alliance, International Federation of Robotics, Companies' Annual Reports

Note:

(1) Company A was established in 2025 and is headquartered in Cupertino, the United States. It is a privately held company. It is primarily engaged in depth cameras and computer vision technologies for robotics, industrial automation, access control and other applications.

(2) Company B was established in 2018 and is headquartered in Shenzhen, China. It is a privately held company. It is primarily engaged in high-performance 3D sensing cameras and VCSEL-based optoelectronic solutions for robotics, AIoT and other applications.

(3) Company C was established in 2018 and is headquartered in Shenzhen, China. It is a privately held company. It is primarily engaged in AI-enabled 3D visual perception solutions, including structured-light and dToF LiDAR solutions for robotics and other intelligent devices.

(4) Company D was established in 2018 and is headquartered in Shenzhen, China. It is a privately held company. It is primarily engaged in intelligent visual perception technologies, including structured-light, ToF and other 3D sensing solutions for robotics, smart devices and other applications.

Barriers to Entry in the Robot 3D Visual Perception Industry

- **Technology Barriers:** Robot 3D visual perception spans optics, chips, depth calculation algorithms, vision algorithms and systems engineering. Companies need to optimize accuracy, frame rate, power consumption, form factor, cost and environmental adaptability, while iterating their technologies and products for different robot form factors and application scenarios, resulting in relatively high technological barriers to entry.

- **Customer and Ecosystem Barriers:** Robot 3D visual perception products require deep integration with robotic platforms, computing platforms, operating systems and algorithm frameworks. Customer development and validation cycles are long, and require suppliers to refine products based on customer requirements and feedback from real-world applications, thereby accumulating industry know-how. Once selected, switching suppliers typically involves significant redevelopment and adaptation costs, creating barriers related to customer relationship and ecosystem compatibility.

- **Manufacturing Barriers**: Robotic 3D visual perception products involve the integration of optical components, sensors, chips, and other precision components, requiring stringent control over assembly, calibration, testing, and quality consistency. Stable performance, high production yields, and reliable large-scale delivery require mature production processes, automated production and testing capabilities, and a comprehensive quality-control system.

EMBODIED INTELLIGENCE DATA COLLECTION DEVICE MARKET ANALYSIS

Definition and Classification of Embodied Intelligence Data Collection Device

Embodied intelligence data collection device refers to specialized equipment and systems used to collect information generated when humans or robots perform tasks in real-world scenarios, including visual and depth information, motion trajectories, device status and interaction feedback. Such equipment provides real-world data for training, skill

learning and continuous iteration, and typically comprise visual, tactile and motion-sensing devices and related software. The market covers dedicated hardware and bundled software, but excludes general-purpose AR/VR devices, computing and storage equipment, standalone data collection services, data cleaning and annotation, dataset sales and data trading.

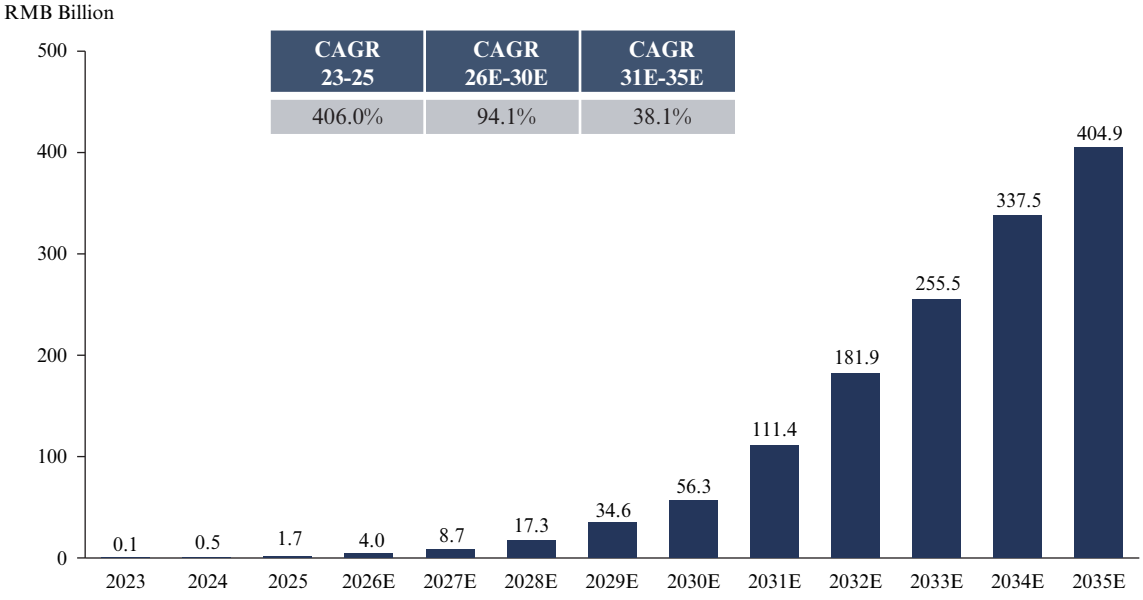
Based on whether data collection relies on a robot platform, embodied intelligence data collection device can be classified into teleoperation (robot-based data collection device) and robot-free data collection device. Teleoperation relies on a robot platform to collect data through remote control, autonomous operation or predefined tasks, while simultaneously recording control commands, robot status, motion trajectories and perception information. The resulting data is closely associated with the specific robot platform. Robot-free data collection device does not rely on a robot platform and instead uses head-mounted, wrist-mounted, handheld or tool-based devices to record visual information, motion trajectories, object states and spatial environmental information during human operations, offering flexible deployment and broad coverage across tasks and scenarios.

Embodied Intelligence Data Collection Device Market Size

As embodied intelligence moves from technology validation to model training and product development, demand for real-world data continues to increase. The global embodied intelligence data collection device market increased from approximately RMB0.1 billion in 2023 to approximately RMB1.7 billion in 2025. During this period, the market remained at a relatively early stage with a small base, and equipment demand was primarily driven by model R&D, robot training and the initial development of data collection systems.

As model training expands across multiple tasks and scenarios, in-house data collection centers and third-party data collection facilities are expected to expand, while both teleoperation and robot-free data collection device are expected to move from small-scale trials to batch deployment. The global embodied intelligence data collection device market is expected to reach approximately RMB56.3 billion by 2030 and further increase to approximately RMB404.9 billion by 2035. Robot commercialization, continuous model iteration and increasingly routine real-world data collection are expected to jointly support sustained market growth.

Embodied Intelligence Data Collection Device Market Size, Global, 2023–2035E



Source: Frost & Sullivan, National Data Administration, Ministry of Industry and Information Technology

Market Drivers and Development Trends of Embodied Intelligence Data Collection Device

- **Growing model-training demand and increasing task complexity are raising requirements for data volume and quality.** Demand spans general-purpose world models and embodied intelligence models tailored to specific industries and tasks. Compared with autonomous driving, general-purpose robotic applications involve more varied tasks, robot configurations and contact interactions, potentially requiring larger and more diverse training datasets. Grasping, assembly and tool use also demand accurate, synchronized multimodal data to capture spatial relationships and action outcomes. As internet and simulation data cannot fully reflect real-world contact, friction and execution variability, these requirements are driving investment in data collection device with enhanced sensing and synchronization capabilities.

- **Commercialization is expected to reshape demand for Teleoperation and Robot-free data collection device, both of which share underlying core perception technologies.** Embodied intelligence remains at an early stage of commercialization. In the short to medium term, robot-free data collection device is expected to predominate, supported by portability, lower deployment costs and efficient collection across scenarios. With large-scale commercialization, teleoperation may become more prevalent, as it directly captures robot control commands, operating states and task outcomes, providing data closely aligned with robotic tasks. Both approaches share core perception technologies, including 3D vision, providing a common technological foundation across collection formats.

- **The shift in data collection demand from experimental validation to large-scale implementation is driving device toward standardization, lightweight form factors and scaled deployment.** Early-stage data collection device was primarily used for laboratory research and specific projects, with a relatively high degree of customization and relatively complex installation and maintenance. As real-world data collection becomes increasingly routine, device is expected to increasingly adopt modular designs and standardized interfaces, while evolving toward portable form factors such as head-mounted, wrist-mounted and handheld devices. Functions including device configuration, operational monitoring, data recording and quality inspection are also expected to become further integrated, lowering barriers to use and improving data consistency.

DEDICATED 3D APPLICATION DEVICE MARKET ANALYSIS

Definition and Classification of Dedicated 3D Application Devices

Dedicated 3D application devices refer to devices primarily designed and used for 3D-related applications. Based on their primary application scenarios, such devices can be categorized into dedicated consumer-grade 3D application devices and dedicated industrial-grade 3D application devices.

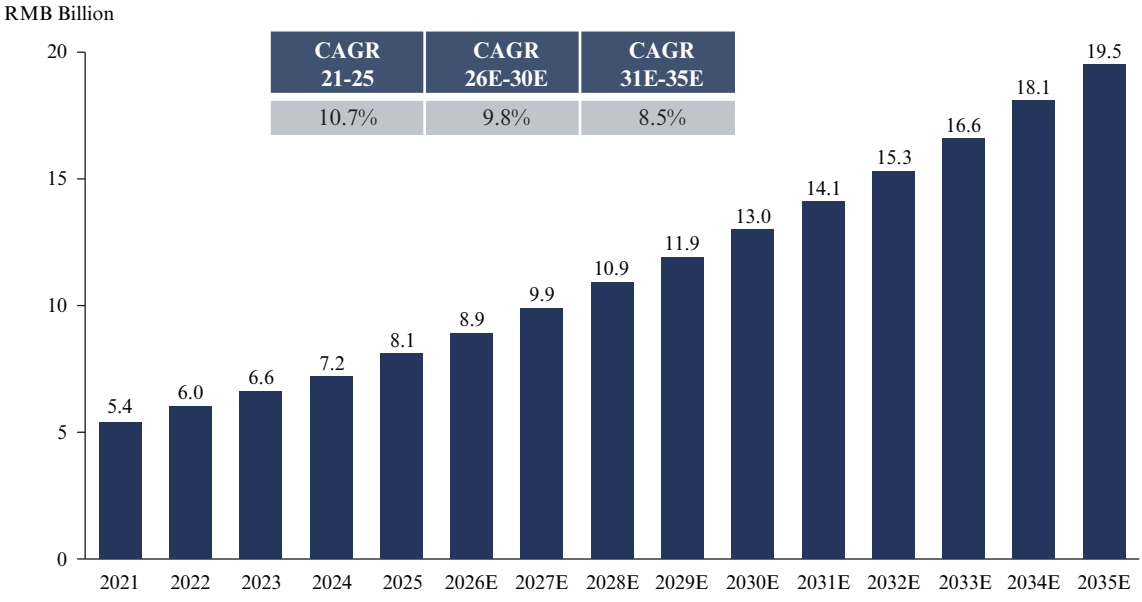
- **Dedicated consumer-grade 3D application devices:** Dedicated consumer-grade 3D application devices are primarily designed for individual and commercial scenarios, with the collection, recognition and application of 3D information relating to humans, objects and spaces as their core functions. They mainly include 3D scanning devices, 3D biometrics recognition payment sensors and other devices, and can be applied in scenarios such as human-body and spatial information collection, identity verification and 3D content generation. Unlike general-purpose terminal devices such as smartphones and AI glasses, these devices are primarily designed around 3D information collection and related applications, rather than treating 3D capabilities as ancillary functions.

- **Dedicated industrial-grade 3D application devices:** Dedicated industrial-grade 3D application devices are primarily used in industrial production and automation scenarios, with 3D information collection, inspection, measurement and positioning as their core functions. They mainly include industrial 3D cameras and 3D scanning devices. Compared with traditional industrial vision devices that primarily rely on 2D imaging, these devices can further acquire 3D information such as depth, shape and spatial position, providing richer spatial information for industrial applications including precision measurement, automated inspection and positioning.

Market Size of Dedicated 3D Application Devices

The global dedicated 3D application device market is expected to grow from approximately RMB5.4 billion in 2021 to approximately RMB8.1 billion in 2025, and further to approximately RMB13.0 billion in 2030 and RMB19.5 billion in 2035. As 3D perception technologies continue to advance, the performance of dedicated 3D application devices continues to improve, and their applications in areas such as industrial inspection, intelligent manufacturing, surveying and mapping, and modeling continue to deepen, growing downstream demand is expected to continue driving the expansion of the dedicated 3D application device market.

Dedicated 3D Application Device Market Size, Global, 2021–2035E



Source: Frost & Sullivan, National Data Administration, International Federation of Robotics, Ministry of Industry and Information Technology

Analysis of Market Drivers and Development Trends of Dedicated 3D Application Devices

- **Demand Side:** As 3D perception technologies mature, dedicated 3D application devices are increasingly used in consumer and commercial scenarios such as human-body and spatial information collection, biometric identification and identity authentication. In smart retail, 3D information collection and recognition can improve the accuracy, security and user experience of identity verification, driving the continued expansion of application scenarios for dedicated consumer-grade 3D application devices. In addition, as industrial automation and intelligent manufacturing continue to advance, demand for 3D information such as object depth, shape and spatial position is increasing across production processes, accelerating the adoption of industrial 3D cameras and 3D scanning devices in applications such as quality inspection, dimensional measurement and object positioning.

- **Technology Side:** Advances in core technologies are driving ongoing improvements in the accuracy, stability and ease of use of dedicated 3D application devices, while also enabling continued cost optimization. As 3D information collection and processing capabilities further improve, these devices can better meet usage requirements across different environments and application scenarios.

- **Product Side:** AI integration and hardware-software coordination are improving usability and application efficiency. The integration of generative AI with 3D modeling and data processing is improving 3D information processing, modeling and application efficiency. At the same time, dedicated 3D application devices are becoming more portable, user-friendly and integrated with supporting algorithms and software, lowering adoption barriers and improving scenario adaptability.

Competitive Landscape Analysis of the Dedicated 3D Application Device Industry

The global consumer-grade 3D application device market is relatively concentrated. Consumer-grade 3D application devices are generally positioned at more accessible price level and are designed for broad-based applications such as 3D content creation, education, cultural and creative applications and light professional use, with greater emphasis on portability, ease of use and cost efficiency. By comparison, industrial-grade products are generally priced higher and are primarily used in professional industrial scenarios requiring higher accuracy, stability and reliability, such as precision measurement, quality inspection and reverse engineering. In 2025, in terms of revenue, the Company ranked first among global dedicated consumer-grade 3D scanning solution manufacturers. In addition, the Company is also the largest provider of sensors for biometrics recognition payment terminals globally.