Humanoid robotics, 2025

Market trends, critical components & strategic shifts

Amid a global surge in technological innovation, the humanoid robot industry is rapidly growing, with leaders like Nvidia driving market expansion. It is seen as a key engine for future global economic growth.

According to the latest DIGITIMES report, global companies are investing in humanoid robots amid the rise of Physical AI. However, high hardware costs mean widespread adoption is unlikely in the next 3-5 years. Humanoid robots are expected to represent just 2% of the global robot market by 2030.

DIGITIMES states that in the near future, "Humanoid Version 0.5" robots—wheeled machines with single or dual-arm grippers/suction devices—will handle simple tasks in limited settings. Widespread, human-like "Humanoid Version 1.0" robots will only be possible once technology improves and costs drop.

No.5, 2025/7

SPECIAL REPORT

Executive summary

Global robot demand is rising due to labor shortages, increasing costs, Industry 4.0 advancements, and AI integration. Humanoid robots have faced high costs and limited commercialization despite ongoing R&D. Recently, AI breakthroughs have attracted significant investment and talent to this sector. DIGITIMES forecasts humanoid robots will hold 0.2% of the US$8.8 billion robot market in 2025, increasing to 0.8% in 2026.

DIGITIMES categorizes humanoid robots into two types and stages. Between 2025 and 2028, the robotics industry will transition from mature industrial and service robots to wheeled robots with single or dual-arm grippers, termed "Humanoid Version 0.5," designed for simple tasks in specific settings. However, the high cost of these humanoid robots, compared to similar industrial robots, limits large-scale adoption. Reducing component costs remains a crucial challenge for their development during this phase.

DIGITIMES predicts that after 2029, advances in technology and economies of scale will lower module costs for bipedal mobility and dual-arm dexterous hands, enabling mass production. "Humanoid Version 1.0" robots with these features will be capable of more complex tasks, boosting their adoption and extending use from industrial to service sectors. As human-robot collaboration grows, development will increasingly emphasize safety regulations alongside hardware and software.

This report will explore the development trends of humanoid robots, uncovering industry trends and key challenges through strategies employed by developers and application scenarios. It will delve into issues and challenges related to software (AI), hardware (components), and safety regulations, as well as potential solutions. Based on these findings, it will outline the short-, medium-, and long-term development trends of the humanoid robot market.

Looking ahead, AI-driven humanoid robots as part of Physical AI will profoundly transform industries. The key questions are when, where, and how this change unfolds, shaping market goals amid uncertainties. These issues are the focus of this research report.

Wing Huang

Wing Huang

DIGITIMES
Analyst

Contents

Figure

The global demand for robots is increasing due to various factors such as labor shortages, rising costs, advancements in Industry 4.0, and the integration of AI technology. The state of the robot market varies across different regions. In the US, the market is propelled by technological innovations in manufacturing, healthcare, and logistics. Significant progress in surgical robots and warehouse automation enhances operational efficiency and precision. Substantial investments in R&D and a strong innovation ecosystem enable the US to maintain a leading position in the global market, particularly in AI-driven mobile robots and medical applications.

The Asia-Pacific region is a powerhouse in the robotics industry, largely due to the robust manufacturing sectors in China, Japan, and South Korea, bolstered by government policies encouraging automation. In China, the automotive and electronics sectors, supported by state-driven automation initiatives, are key growth drivers. Japan is leveraging robotics to address issues arising from its aging population, with an emphasis on elderly care and personal assistance technologies. South Korea leads in both industrial and service robotics. Together, these countries' strong manufacturing capabilities and strategic policy support the position of Asia as a global leader in the robotics market.

In Europe, Germany, Italy, and France spearhead the EU's advancements in industrial automation and medical robotics, largely propelled by an aging demographic and a healthcare workforce deficit. The EU's focus on automation policies and the promotion of safe robotic technologies is significantly driving market expansion, especially in automotive manufacturing and medical sectors. Furthermore, the region excels in the integration of collaborative robots (cobots) and artificial intelligence. The capacity of cobots to operate safely alongside humans is swiftly broadening their utilization across industries including manufacturing, agriculture, and healthcare.

According to DIGITIMES, humanoid robots will evolve gradually, progressing through "Humanoid 0.5 Version" and "Humanoid 1.0 Version." The "Humanoid 0.5 Version" is tailored for specific environments and basic movements, utilizing modular mobility and object-handling frameworks to minimize costs and simplify the initial deployment of humanoid applications. In contrast, the "Humanoid 1.0 Version" will exhibit a human-like design,

incorporating bipedal mobility and dual arms with sophisticated hands, enabling the execution of more intricate tasks.

Figure 1 Industrial, service, humanoid robot architecture

	Industrial	Service	Humanoid	
			Version 0.5	Version 1.0
Head (Eyes + Brain)	X	X	V	V
Hand	V Singled-armed Gripper for pickup	X	V Single and dual-armed Gripper for pickup	V Dual-armed Dexterous hands for pickup
Foot	X	V Wheels	V Wheels	V Bipedal

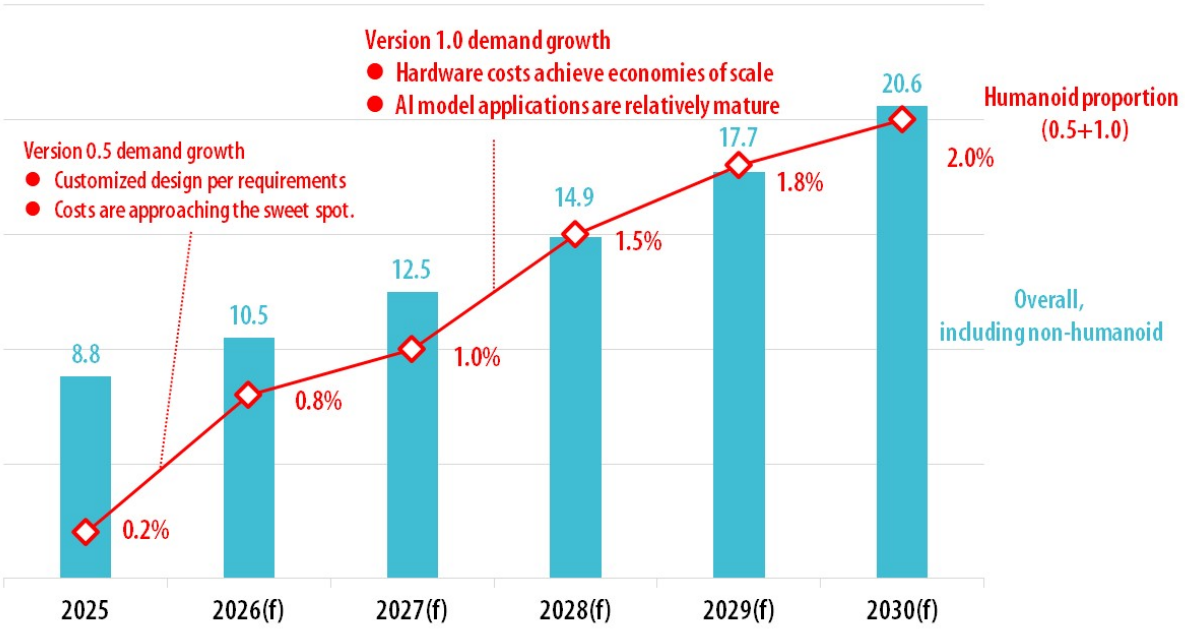
Source: DIGITIMES, 2025/7

According to DIGITIMES, the global market for robots is projected to reach US$8.8 billion by 2025. In this landscape, overall humanoid robots are expected to comprise around 0.2% of the market share. Between 2026 and 2030, the market is anticipated to undergo two major growth phases. The first significant expansion is set for 2026, driven by "Humanoid Version 0.5." This version is expected to capitalize on a well-established ecosystem that includes robotic arms and wheeled mobility systems. It will be able to efficiently deliver customized solutions based on individual user requirements, with production costs nearing an optimal point. This development is predicted to substantially increase the demand for humanoid robots in specific sectors, enhancing their market share from 0.2% to 0.8%, marking an increase of approximately 0.6 percentage points.

A second growth wave is anticipated in 2028, with the "Humanoid 1.0 version" significantly propelling market expansion. This growth will be spurred by economies of scale in hardware costs and the sophistication of AI model applications. The humanoid robot market share is expected to increase by approximately 0.5 percentage points, reaching 1.5%.

By 2030, the global robot market is projected to reach US$20.6 billion, with humanoid robots making up around 2% of the market. These growth waves illustrate how advancements in technology and cost reductions are driving market expansion. Particularly, the swift adoption of humanoid robots in specific applications and improvements in their cost structure will become crucial factors driving this expansion.

Figure 2 Global robot and humanoid robot market size forecast, 2025-2030 (US$b)



Source: DIGITIMES, 2025/7

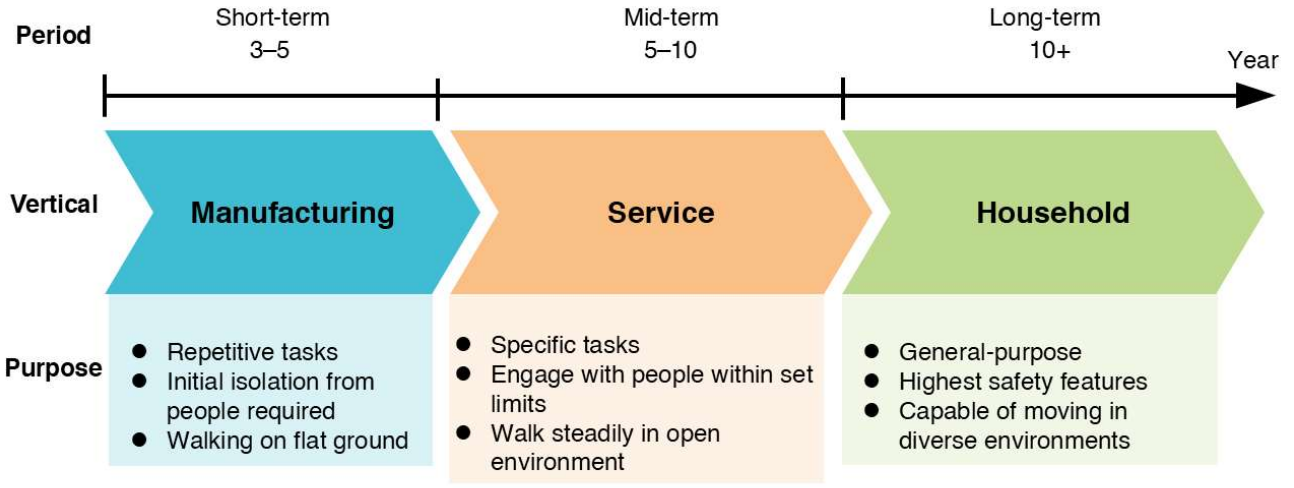
Humanoid robots are currently in the nascent phase of their development. Over the next three to ten years, advancements in mobility, intelligence, and safety features are expected to facilitate their entry into diverse fields, supporting humans and ultimately improving quality of life.

Manufacturing environments are generally enclosed and characterized by predictable, standardized procedures, minimizing unexpected situations. On the other hand, service environments present a diverse range of conditions with unpredictable processes that resist standardization. The household domain adds an additional layer of complexity, featuring

highly variable conditions unique to each household. This complexity demands advanced autonomous planning and exceptional hand dexterity to effectively manage highly customized tasks in often chaotic settings.

Humanoid robots will soon expand beyond the manufacturing sector, where they will perform tasks beyond the capabilities of traditional industrial robots. They will also revolutionize the service and household sectors by assisting with a range of daily chores, ultimately enhancing quality of life.

Figure 3 Humanoid robot use and growth in the short, medium, and long term



Source: Companies, compiled by DIGITIMES, 2025/7

Generally speaking, the momentum of the global robotics industry mainly comes from demands for production line manufacturing, transportation, and even visual recognition required by factories. This helps reduce the physical and psychological workload of factory personnel, thereby minimizing unnecessary human errors and improving operational efficiency. The robotic systems needed in factories are mostly multi-axis robotic arms, driven by multiple motors to rotate the arms in different directions or control dexterous hands to meet various manufacturing scenario requirements within the factory.

Furthermore, to align with the demands of Industry 4.0 and smart factory initiatives, production lines must be able to flexibly adapt to a wide range of customer-specific

manufacturing requirements. The system design of multi-axis robotic arms increasingly integrates a variety of sensors, with machine vision and distance sensors among the most used. For more specialized application scenarios—such as human-machine collaboration or high-temperature environments, additional sensor types like MEMS accelerometers, gyroscopes, and temperature sensors can be effectively employed to enhance functionality and safety.

From the perspective of system control, as multi-axis robotic arms need to meet diverse manufacturing field requirements, the integrated control of each robotic arm and the coordinated operation of multiple motors inevitably require controllers to play a central integration role. The controllers required by robotic arms can generally be regarded as a vertical application of embedded system motherboards. In the early days, processors used in such embedded systems were dominantly x86 processors. However, with the increasing visibility of Arm CPU-based processors in the market, considerations such as cost-performance ratio have led embedded system vendors to adopt processor products primarily based on Arm CPUs in recent years, providing customers with more diverse options.

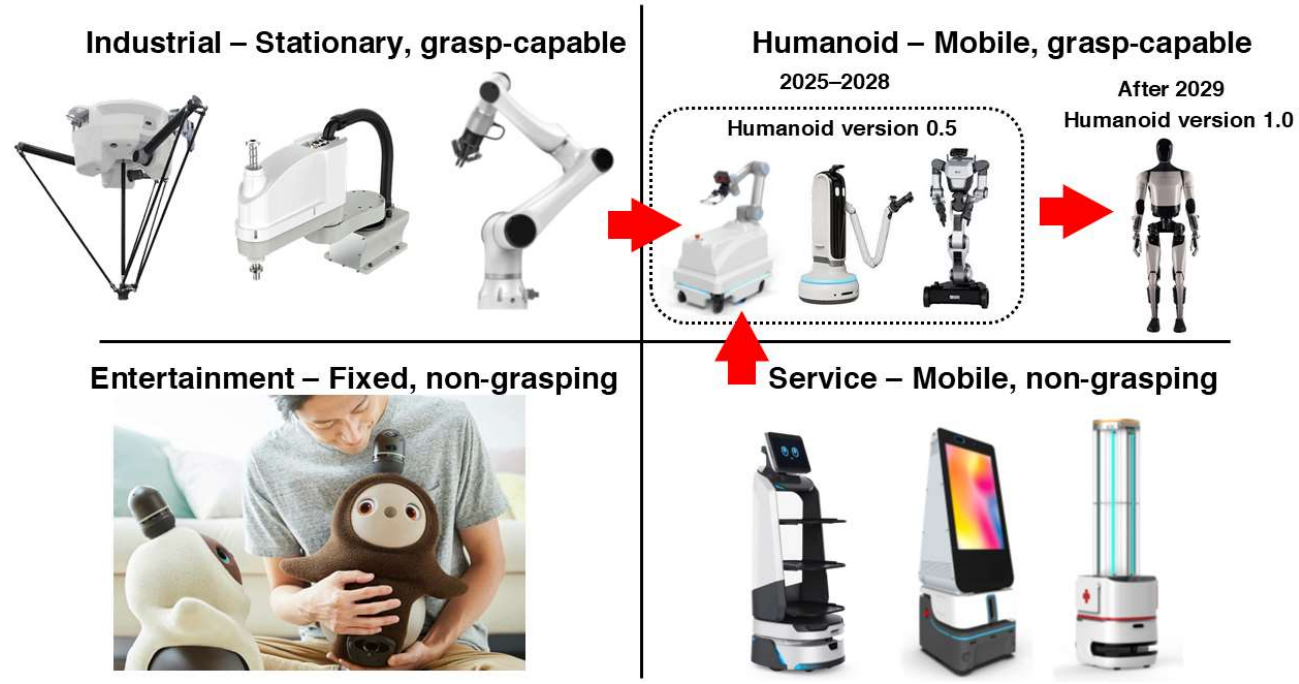
However, compared to the single-task requirements of industrial multi-axis robotic arms, humanoid robots face diverse and complex service scenarios. Furthermore, given that humanoid robots are still in the early stages of development, there's no consistent, specific content in current industry regulations to guide how to ensure user safety in human-robot interaction scenarios. Consequently, the number of sensors and MCUs required will inevitably increase to enhance system stability and safety. Additionally, the performance of controller components must be significantly improved. For instance, upgrades are needed in areas such as the number of CPUs built into processors, core clock speeds, and manufacturing processes to drive performance improvements in controller components.

In terms of signal transmission, the growing number of sensors and the increasing resolution of image sensors will lead to a significant rise in data transmission volume. As a result, maintaining stable and low-latency signal transmission becomes critical. Overall, both the cost of semiconductor components and the complexity of system development for humanoid robots are expected to increase considerably—posing a challenge to their short-term advancement and widespread adoption.

According to DIGITIMES, from 2025 to 2028, the global robotics industry is set to evolve from traditional industrial and service robots to advanced models equipped with wheeled mobility and single or dual-arm grippers or suction nozzles—referred to as 'Humanoid Version 0.5.' These robots are designed for specific environments and simple tasks, with their modular designs enhancing cost efficiency in mobility and object handling. This advancement paves the way for the early-stage deployment of humanoid robot applications. Wheeled platforms provide significant cost benefits compared to complex bipedal systems and are especially effective for logistics, transportation, and basic object manipulation. They find wide applications in manufacturing, warehousing, and service sectors.

Looking beyond 2029, advancements in technology and economies of scale are expected to reduce the costs associated with bipedal mobility and dual-arm dexterous hands significantly. These developments will spearhead the mass production of "Humanoid Version 1.0" robots. Equipped with bipedal mobility and dual arms featuring advanced dexterous hands, these robots will be capable of performing complex tasks such as precise object manipulation, effective human-machine collaboration, and versatile cross-disciplinary applications. They will find extensive use across various sectors, including healthcare, home services, education, and entertainment, swiftly integrating into everyday life. As AI technologies advance, these robots will also exhibit enhanced environmental adaptability and autonomy, further accelerating their market penetration and heralding a new era of widespread adoption of humanoid robots.

Figure 4 Humanoid robot development, 2025–2030



Source: DIGITIMES, 2025/7

Analysts

OUR TEAM

Wing Huang
Analyst
#AI Industry

CY Yao
Analyst
#Semiconductor & Chipsets

Jin Pai
Analyst
#Robotic &
Smart Manufacturing

Zouhao Shen
Analyst
#Robotic & Edge Computing

Eva Lin
Analyst
#Robotic & IoT

About DIGITIMES

DIGITIMES boasts a network of over 1,200 members from Taiwan's leading tech companies, covering key players in the industry. This unique advantage allows DIGITIMES to access firsthand industry information and accurately track global technology supply chain trends. We are dedicated to advancing cutting-edge technology research, providing critical supply chain insights, and leading technological development. Our research areas include semiconductors, AI, IoT, information technology, consumer electronics, telecommunications, automotive technology, and display technologies.

Supply Chain Analysis

In today's challenging economic environment, companies need deep insights and precise data to formulate strategies. DIGITIMES provides comprehensive coverage of the entire process, from semiconductor design and manufacturing to servers and end products, including all stages of component production and distribution. We offer accurate, transparent, and systematic analysis to help businesses make informed decisions within complex supply chains.

Expert Team

DIGITIMES consists of experienced industry experts who bring deep expertise in their respective fields, delivering high-quality and thorough research reports. Our research is based on reliable and authoritative data sources, including collaborations with industry-leading companies. We employ rigorous scientific research methodologies to ensure the accuracy and credibility of our reports.

Research Report Content

DIGITIMES's reports cover global and Taiwanese production and sales data, industry development trends, technological advancements, strategies of leading companies, and competitive dynamics. We also focus on supply chain trends in regional and emerging markets and the development of key components.

Customized Research and Consulting Services

DIGITIMES provides customized research and consulting services tailored to businesses' unique needs. Our offerings include technology trend forecasting, competitor analysis, and supply chain insights. With deep industry expertise, we help businesses seize innovation opportunities, make informed decisions, and strengthen their competitive edge in a rapidly evolving tech landscape.

DIGITIMES Services: https://www.digitimes.com/reports/services/

Contact us

For any inquiries, feel free to contact us. We're here to help!

Service hours: Mon - Fri, 09:00-18:00 (UTC+8)

Fax: +886 2 8712 3366

TEL: +886 2 8712 8866

Email: subscription@digitimes.com

Disclaimer

The contents of the report provided by our company are based on information from sources recognized by us and judgments made as of a specific date. However, due to rapid industry changes, incomplete information, and other uncertain factors, we do not guarantee the accuracy and completeness of this research report in the future. Any opinions and estimates in the report are subject to change without notice.

The information in this research report is provided for general reference only and is not intended as specific advice for any particular individual or entity. Users should exercise their own judgment and take responsibility for the outcomes if they use or reference this information for decision-making purposes. Except in cases where liability is clearly attributable to DIGITIMES, users may not hold us responsible for any direct or indirect damages resulting from the use of this research report. The content of this investment report is based on information believed to be reliable but does not make any explicit or implicit representations or warranties regarding the accuracy, completeness, or correctness of the data. Opinions presented in this research report may be amended or withdrawn without notice to users. The contents of this research report are copyrighted by DIGITIMES Inc. (hereinafter referred to as DIGITIMES) and are strictly protected against copying and imitation. For specific details, please refer to the copyright statement included in the report.

Copyright statement

All content published on the DIGITIMES website, such as articles, photos, images, illustrations, audio, video, files, website layout and design, are protected by the laws of the Republic of China (Taiwan), international copyright laws, and relevant intellectual property laws. This intellectual property, including but not limited to trademarks, patents, copyrights, trade secrets, and proprietary technology, is owned by DIGITIMES or its collaborative content providers.

Violation of the copyright policy may result in legal consequences, including but not limited to fines and lawsuits. Inadvertent violation of copyright, such as not realizing a piece of content is copyrighted, will also be regarded as illegal.

Users may download or copy website and print content or services for personal, non-commercial use only. Users must comply with all relevant copyright laws. Without explicit authorization, users may not alter, publish, broadcast, resell, reproduce, modify, distribute, perform, display, or utilize any part or the entirety of the content and services on the DIGITIMES website for profit.