



# The Enlightenment of the Development of Humanoid Robot Industry in Advanced Provinces on Shandong Province

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**Abstract.** With the accelerated advancement of scientific and technological innovation, the humanoid robot industry is gradually entering a period of explosive growth. This paper compares and analyzes the practical experience of advanced provinces such as Beijing, Shanghai, Guangdong, and Zhejiang in the field of humanoid robot industry. Combining the industrial foundation and policy practices of Shandong Province, it proposes strategic insights for accelerating the development of the humanoid robot industry in Shandong, aiming to provide references for regional industrial upgrading.

**Keywords:** Humanoid Robot; Industry Development; Shandong Province

## 1 Introduction

With the rapid development of artificial intelligence, big data, cloud computing, and other technologies, the humanoid robot industry has become an important part of future industries. Humanoid robots, with their unique human-like morphology and interactive capabilities, have shown broad application prospects in medical, educational, service, industrial, and other fields. The Central Committee of the Communist Party of China and the State Council highly value the development of future industries, clearly stating that scientific and technological innovation should drive industrial innovation, especially using disruptive and cutting-edge technologies to give birth to new industries, new models, and new driving forces. Against this backdrop, this paper aims to provide beneficial insights for the future development of Shandong Province's humanoid robot industry by analyzing the development experience of advanced provinces.

## **2 Overview of Humanoid Robot Industry**

### **2.1 Concept**

Humanoid robots, also known as anthropomorphic robots or human-like robots, are typically designed with human characteristics, such as heads, bodies, limbs, and facial expressions, to interact more naturally with humans. The industry has gone through four stages: initial exploration, integrated development, high-dynamic development, and intelligent development [1].

### **2.2 International Development Status**

Currently, the core component research and development of humanoid robots is mainly concentrated in Japan, the United States, Europe, and China. Japan, as a major producer and exporter of industrial robots, has a complete robot industry chain and significant advantages in components such as motors, sensors, and reducers. The United States, leveraging its superior computing power, is driving the intelligent development of humanoid robots. The European humanoid robot industry is characterized by its diversity, covering suppliers and manufacturers from multiple countries, and showing strong competitiveness in control systems and artificial intelligence processors.

### **2.3 Domestic Development Status**

In the period before 2022, China's humanoid robot industry remained in the stage of basic research and technological accumulation. However, since 2023, the industry has entered a period of rapid development. With the joint efforts of academia, industry, government, and capital, the development momentum of humanoid robots has been rapidly released. In terms of policy support, the Chinese government has attached great importance to the development of the robot industry, especially since 2021, when a series of relevant policy plans were introduced to provide strong support for the future development of the humanoid robot industry. In terms of industrial distribution, the Beijing-Tianjin-Hebei, Yangtze River Delta, and Pearl River Delta regions have become the main agglomeration areas for China's robot industry, with Beijing, Shenzhen, and Shanghai standing out in terms of robot industry strength. In terms of technological innovation, China has ranked first in the world in the number of humanoid robot technology patent applications, with a focus on the layout of body structure and core components [2].

### **3 Development Status of Humanoid Robot Industry in Advanced Provinces**

#### **3.1 Development Status of Humanoid Robot Industry in Beijing**

In terms of industrial planning, Beijing has successively issued a number of policy documents, clearly identifying humanoid robots as a key direction for development and focusing on breakthroughs in key core technologies such as general prototype machines and general artificial intelligence models for humanoid robots [3]. In terms of support measures, Beijing has implemented the "Foundation Building" project for the robot industry, strengthened the development and supply of robot industrial land, and supported the construction of public platforms to provide strong support for the development of the humanoid robot industry. In terms of scientific and technological innovation, Beijing has a solid foundation for innovation and rich innovative resources, including many well-known universities, scientific research institutes, and new research and development institutions, providing strong support for the development of the humanoid robot industry. In terms of industrial layout, robot enterprises are distributed in various districts of Beijing, forming several industrial agglomeration areas and industrial parks, with Haidian, Daxing, and Tongzhou districts being the most concentrated, accounting for about 38% of the total number of enterprises.

#### **3.2 Development Status of Humanoid Robot Industry in Shanghai**

In terms of industrial planning, Shanghai has clearly proposed to build a globally influential robot industry innovation hub, aiming to create a 100 billion yuan robot-related industrial scale and construct three public service platforms, including a humanoid robot manufacturing innovation center [4]. In terms of scientific and technological innovation, Shanghai is one of the earliest cities in China to develop robots and has formed an innovative system matrix covering universities, scientific research institutes, innovation platforms, and innovative enterprises. In terms of industrial layout, Shanghai has fully leveraged the advantages of the Yangtze River Delta region in robot industry foundation, financial capital, and innovative and entrepreneurial talents. It has built public platforms such as the Humanoid Robot Innovation Center and formed several robot industry agglomeration areas, including Zhangjiang Robot Valley and Shanghai Robot Industrial Park.

#### **3.3 Development Status of Humanoid Robot Industry in Guangdong**

In terms of industrial planning, Guangdong Province will accelerate the research and development of robot brains, limbs, bodies, and their key core components, promote innovation in the application scenarios of intelligent robots, and build an embodied intelligent robot innovation center [5]. In terms of scientific and technological innovation, Guangdong has continuously strengthened its cooperation with foreign leading enterprises. For example, Shunde, Foshan, has successfully introduced the international leading enterprise KUKA through the local enterprise Midea Group and built an in-

dustrial service area and robot college in cooperation with Germany, as well as an international exhibition center, promoting the agglomeration of the local industrial robot industry. In terms of industrial layout, centered on the Pearl River Delta, a "whole machine + core components + large model" ecosystem has been formed. Shenzhen, Guangzhou, and Dongguan have clear divisions of labor: Shenzhen focuses on industrial application scenarios (such as BYD factory training), Guangzhou focuses on education and medical scenarios, and Dongguan promotes the integration of intelligent manufacturing and robot technology.

### **3.4 Development Status of Humanoid Robot Industry in Zhejiang**

In terms of industrial planning, Zhejiang focuses on "brain," "cerebellum," and "limbs," breaking through "bottleneck" technologies such as servo motors and sensors, aiming to achieve an annual production of 20,000 whole machines, a core industry scale of 20 billion yuan, and an associated industry scale of 50 billion yuan by 2027[6]. In terms of scientific and technological innovation, Zhejiang has both Zhejiang University with a strong research accumulation and new research and development institutions such as the Zhejiang Lab and the Ningbo Institute of Materials Technology and Engineering of the Chinese Academy of Sciences, providing solid support for the development of the humanoid robot industry. In terms of industrial layout, Zhejiang has basically formed a robot industry development pattern with Binjiang and Xiaoshan Robot Town in Hangzhou and Yuyao Robot Town in Ningbo as the core, and characteristic development in Wenzhou, Jiaxing, Taizhou, and other places.

## **4 Development Status and Challenges of Humanoid Robot Industry in Shandong**

### **4.1 Development Status**

Shandong, as an industrial powerhouse, has a good foundation for developing the humanoid robot industry. In terms of industrial planning, Shandong has proposed to preliminarily establish a humanoid robot innovation system by 2025, cultivate about five key enterprises, and by 2027, cultivate ten core enterprises with a core business output value of over 100 million yuan, reaching a comprehensive industrial strength at the national advanced level [7]. In terms of scientific and technological innovation, universities and research institutions in Shandong have achieved significant research results in the field of humanoid robots, and some enterprises have developed humanoid robot prototypes with independent intellectual property rights. In terms of industrial layout, enterprises in Shandong have covered most of the humanoid robot industry chain, with leading enterprises and major research institutes mainly concentrated in Jinan and Qingdao.

## **4.2 Challenges Faced**

Despite the progress made in the field of humanoid robot industry, Shandong still faces many challenges. First, the innovation capacity needs to be improved. According to relevant data, Shandong's effective invention patents in humanoid robots and the number of innovation institutions are lower than those of advanced provinces such as Beijing, Guangdong, and Zhejiang. Second, the industrial environment needs to be enhanced. Currently, there are few humanoid robot whole machine manufacturing enterprises in Shandong, and the investment and financing environment for enterprise development is lacking. Third, there is a lack of comprehensive research platforms. The research and innovation of humanoid robots involve multiple disciplines and require the support of provincial or national comprehensive research platforms, which Shandong has not yet established.

## **5 Suggestions for the Development of Humanoid Robot Industry in Shandong**

### **5.1 Strengthen the Research and Development of Key Core Technologies**

It is recommended to establish a major science and technology project for humanoid robots, focusing on supporting key enterprises and universities in Shandong to tackle core components and common key technologies. Particular emphasis should be placed on the technological research and development capabilities of high-performance components such as motor drivers, dexterous hands and end-effectors, and complex motion control. The industry-university-research-application operation mechanism should be improved to build an integrated innovation system for advanced technology research, pilot testing, engineering application, and industrial incubation. This will form core technologies with independent intellectual property rights and enhance Shandong's core competitiveness in the humanoid robot industry.

### **5.2 Strengthen Policy Leadership and Forward-Looking Layout**

On the one hand, it is necessary to formulate clearer industrial development plans and policies, increase policy rewards for research and development and technology transfer, and improve policy support methods. This can be achieved through the establishment of special funds and the provision of loan interest subsidies to promote the rapid transformation and application of innovation results. On the other hand, forward-looking layout should be made for the integrated development of humanoid robots with cutting-edge technologies such as artificial intelligence, new materials, and brain-computer interfaces. This will lead to the formation of a number of provincial independent brand characteristic products and promote the formulation of relevant standards.

### **5.3 Build Humanoid Robot Industry Innovation Platforms**

Leveraging the agglomeration advantages of robot industries in Jinan and Qingdao, it is recommended to guide the construction of collaborative innovation platforms in the field of humanoid robots. By gathering leading enterprises and key research institutions in Shandong, a humanoid robot technology innovation center should be jointly established to explore industry common key technologies and clarify key tasks for breakthroughs. At the same time, the construction of industry-research docking platforms should be strengthened to promote the transformation of innovation results, the cultivation of industrial ecosystems, the incubation of characteristic enterprises, and the training of professional talents, providing strong support for the sustainable development of the humanoid robot industry.

### **5.4 Promote Deep Integration of Industry-University-Research**

The deep integration of industry-university-research is an important way to drive the innovative development of the humanoid robot industry. Shandong should encourage enterprises and research institutions in the humanoid robot industry to form industry-research consortia to achieve deep integration in technology research and development, product development, market promotion, and other links. Joint research projects targeting key technical difficulties in the development of the humanoid robot industry can be established, with enterprises and research institutions jointly undertaking research tasks.

### **5.5 Strengthen Talent Training and Introduction**

Deepen the integration of industry and education to establish professional talent training bases for humanoid robots, offering systematic and specialized training courses to cultivate talents with professional skills and knowledge. In addition, a talent introduction plan for the humanoid robot field should be formulated, and a sound talent introduction mechanism should be established to simplify the introduction process and provide excellent talents with a good development platform and career advancement channels. By strengthening talent training and introduction, continuous talent support can be provided for the sustainable development of the humanoid robot industry.

## **6 Conclusion**

The development of the humanoid robot industry is an important driving force for future economic growth and technological innovation, which will bring significant opportunities to Shandong. Therefore, Shandong must focus on strengthening core technology research and development, improving policy support, building collaborative innovation platforms, promoting deep integration of industry, academia, and research, and cultivating high-quality talent teams, fully leveraging its own advantages,

overcoming shortcomings, and achieving rapid and sustainable development of the humanoid robot industry.

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