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Commercialization of AI Robots, Service Robots and Humanoid Robots

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Abstract

Research Direction and Need: The AI robot market is showing explosive growth due to the convergence of artificial intelligence (AI) and robot technology. AI robots are leading innovation in various industries such as manufacturing, medical care, and logistics, and the market size is expected to expand more than three times over the next 10 years. The global AI robot market is expected to grow 280% by 2030 to reach 64 billion dollars (about 85 trillion won). This is a phenomenon that combines technological advances in AI-based robots with increasing demand for automation by companies. The AI robot market is expected to grow four times faster than the overall robot market. This is because AI-based robots are differentiated in autonomy, learning ability, and complex task performance capabilities from existing automated robots. The Ulsan regional economy is weakening the international competitiveness of the three major industries, automobiles, shipbuilding, and petrochemicals, due to the recent decline in oil prices, falling exchange rates, and deteriorating domestic and foreign economic conditions, such as the yen. Ulsan's potential growth rate is estimated at 2.2%, and continuous economic growth and industrial structure innovation are needed. Therefore, this study focuses on automobile and ship-related industries amid the prediction of rapid growth in the AI robot market, and needs to break away from traditional industries in specialized regional economies and establish themselves as future industries. The necessity of this study is to closely analyze the flow of AI robots and service robot industries and humanoid robot industries, which are establishing themselves as future industries, and to strengthen strategic responses and investments so that the regional economy can become global competitive.

***Keywords**: Artificial Intelligence (AI), Service Robots Commercialization, Humanoid Robotics Industry, AI-Driven Automation, Robotics Market Growth, Human–Robot Interaction, Technological Innovation in Robotics, Future of Work and Robotics, AI Applications in Industry, Global Robotics Commercialization Trends.*

1. Definition of intelligent robots

Intelligent robots are mechanical devices that operate autonomously by recognizing the external environment by themselves and judging the situation. These robots have the ability to receive information through various senses, such as sight and hearing, and to make decisions for themselves.

1.1 *Key Characteristics*

Artificial intelligence (AI), sensor technology, and control systems are combined to perform tasks autonomously in a given environment.

It is a human-oriented robot that interacts with humans and provides various services such as housekeeping support, education, and entertainment.

It has high autonomy and adaptability to make decisions and adapt to environmental changes based on real-time data without the need for predetermined programs.

Technical configuration

Situation judgment and learning ability through artificial intelligence (machine learning, deep learning, etc.).

Sensors (cameras, lidars, etc.) recognize their surroundings in real time and perform tasks based on them.

Move autonomously or adjust motion through a control system or motion algorithm.

1-2. Legal Justice (Korea)

In the Intelligent Robot Development and Distribution Promotion Act, "intelligent robots" are defined as mechanical devices that recognize the external environment by themselves, judge the situation, and operate autonomously.

In other words, unlike existing industrial robots limited to simple repetitive tasks, intelligent robots are advanced convergence technology robots that can judge themselves based on various senses and artificial intelligence and respond to various environments

2. Differences between intelligent and industrial robots:

The biggest differences between intelligent robots and industrial robots are their autonomy, work environment, and ability to interact with humans.

2-1. Key differences

1)work environment

Industrial robots are mainly used in controlled, static environments (e.g., automotive factories, semiconductor lines, etc.), and are optimized for performing repetitive tasks.

Intelligent robots operate dynamically in complex and unpredictable real-world environments, and can adapt in real-time to environmental changes.

2)Autonomy and Judgment

Industrial robots perform simple iterations according to predetermined commands.

Intelligent robots recognize and analyze given situations using sensors and artificial intelligence (AI) technology to judge themselves and handle various tasks autonomously.

3)human interaction

Industrial robots operate mainly independently, with extremely limited direct interaction with humans.

Intelligent robots provide customized services through various interactions, such as communicating and cooperating with humans.

4)field of application

Industrial robots are mainly used in mass production, repetitive process automation, and so on.

Intelligent robots perform complex tasks not only in manufacturing but also in various fields such as healthcare, services, and homes.

a comparison table

Sortation	industrial robot	an intelligent robot
working environment	Static, controllable	Dynamic, complex, unpredictable
autonomy	Low (recurring operations)	High (Situation Judgment and Autonomous Operation)
human interaction	restrictive	active interaction with humans
Key technologies	Automatic control, repetitive program	Artificial intelligence, sensors, self-control
Applicable field	Manufacturing, assembling, mass production	Services, healthcare, education, home, etc

As such, intelligent robots are more human-friendly, flexible, and adaptable to complex environments based on artificial intelligence, sensing, and autonomous control technologies, which are essential differences from industrial robots.

3. Trends in AI Robot Market

3-1. Smart Robot: A smart robot is a robot that can sense the environment by itself and act independently based on AI and sensor technology.

1)Definition and Key Features

Unlike machines that repeatedly execute simple human commands, smart robots collect and analyze data in real time to determine their behavior according to changes in their surroundings.

Sensors (cameras, microphones, lasers, etc.) recognize and act on physical environments, objects, and people.

AI software has excellent learning and adaptation capabilities, and not only simple tasks but also complex problems or interactions with users.

2)Technical components

Awareness of external situations with various sensors (visual, auditory, etc.).

Predictions and judgments are performed with AI algorithms based on machine learning and deep learning.

Autonomous movement and motion coordination through real-time control systems.

Automatically move and perform tasks with the battery and drive unit (wheels, legs, etc.).

3)Utilization and development directions

It is actively used not only in manufacturing but also in

various fields such as services, healthcare, and home.

It is leading innovation in autonomous driving, smart home, logistics, and transportation.

It is developing in a human-friendly direction such as customized services and understanding human emotions.

Smart robots are next-generation robots with autonomous thinking, learning, complex judgment, and adaptability, not just automation through AI technology convergence.

3-2. Autonomous Mobile Robot: Autonomous Mobile Robot (AMR) is an intelligent robot that recognizes its surroundings, finds and moves the optimal route in real time, and performs tasks. Unlike conventional automated guided vehicles (AGVs), it has high flexibility to detect and avoid obstacles even in dynamic and complex environments without relying on specific routes or tracks.

1)Key Concepts and Features

It uses various sensors (lidar, camera, ultrasonic, etc.) and AI technologies to accurately detect the surrounding environment, estimate the location autonomously based on this, and design an efficient travel path with mapping (SLAM) technology.

It recognizes and avoids obstacles while working, and operates multiple robots simultaneously as a cloud-based management system.

It can be operated continuously 24 hours a day using high-performance sensors, stable charging systems, and battery management technology, and is used in various industries such as logistics, manufacturing, and medical care.

2)The Importance of Autonomous Mobility Robots

It provides excellent efficiency in automated product transportation and inventory management in warehouses and contributes to labor savings and productivity improvement.

It also increases the safety of the work environment by working with humans to perform repetitive and dangerous tasks instead.

Autonomous mobile robots are smart robots that recognize the surrounding environment, judge themselves, move freely, and perform tasks, and are key technologies that lead automation innovation in various industries such as logistics and manufacturing.

3-3. Humanoid Robot: A humanoid robot is a robot with a human-like shape and motion, which has a human-like appearance with two arms and two legs, and is an intelligent machine designed to mimic human behavior such as walking, hand movements, and facial expressions.

1)Key Features

It has a human-like body structure (head, torso, arms, legs, etc.) for natural human-robot interaction, and performs autonomous judgment and action.

Artificial intelligence, sensors (cameras, microphones, tactile sensors, etc.) and machine learning technologies are concentrated, enabling them to recognize their surroundings, learn, and collaborate with humans.

Advanced motion control technology enables complex movements and walking, and emotional artificial intelligence enables users to recognize and respond to emotions.

2)field of application

Work with or on behalf of humans in various fields such as industrial sites, services, healthcare, and education.

It is developing into a form that allows emotional exchange and is attracting attention as a future robot that brings innovation to society as a whole.

In other words, humanoid robots are advanced robots that not only mimic human forms, but also cooperate with humans through intelligent and autonomous functions and perform various roles.

3-4. Industrial robots*:* Industrial robots are programmable and automatically controlled multipurpose work machines used in manufacturing and automation environments, mainly robots specializing in performing repetitive and precise tasks. According to the International Federation of Robotics (IFR), industrial robots are defined as "multipurpose manipulators capable of automatic control and reprogramming with three or more programmable axes."

1)Key Features

It repeatedly performs various tasks such as assembly, welding, packaging, transportation, and quality inspection, mainly at factories or production sites.

It operates automatically without the need for an operator to intervene, replacing repetitive and dangerous tasks that are difficult for humans to do.

It exists in various forms, and typically includes multi-joint robots, orthogonal robots, SCARA robots, Delta robots, and cooperative robots (cobots).

It consists of sensors, manipulators (robot arms), drive units, controls, and end effectors (tools).

2)Classification

Multi-joint robot: structures similar to human arms, highly versatile with multi-axis movement.

Orthogonal robot (orthogonal coordinate type): linear motion in the X, Y and Z axes, precise position control.

Skara Robot: fast horizontal movable, suitable for electronic component assembly, etc.

Delta robot: It moves at high speed and is used to handle lightweight objects.

Cooperative Robot (Cobot): Safely cooperating with humans, preventing collisions with sensors.

Industrial robots are positioned as essential automation equipment for improving productivity, reducing costs, and improving work safety in many industries centered on manufacturing. Industrial robots are multipurpose robots that can be programmed and automatically controlled in manufacturing and automation environments, mainly performing repetitive and precise tasks. The International Federation of Robotics (IFR) defines industrial robots as "automatically controlled and reprogramable multipurpose manipulators with more than three programmable axes."

3)Key Features

It repeatedly performs various tasks such as assembly, welding, packaging, transportation, and inspection at factories or production sites.

It operates automatically without operator intervention and performs dangerous or repetitive tasks that are difficult for humans to perform.

Depending on the structure, it is classified into multi-joint robots, orthogonal coordinate robots, SCARA robots, delta robots, cooperative robots (cobots), etc.

Classification and Use

type	Characteristics	main use
an articulated robot	Multi-axis operation similar to human arms	Precision assembly, welding, etc
orthogonal robot	x, y, z axis direct hand movement	Positioning operations
Scara Robot	Fast horizontal movement	Electronic component assembly
Delta Robot	High-speed movement and lightweight object handling	Food packaging, high-speed picking
Cooperative Robot (Cobot)	Collaborate with humans and incorporate collision detection and stopping capabilities	collaborative work

Industrial robots are essential automation equipment in the modern industry and play a key role in improving productivity and work safety.

3-5. Cooperative robot: It refers to a robot that works together in the same space as a person and can physically interact with people. In other words, it is a robot designed to allow people and robots to collaborate and perform tasks, and aims to increase work efficiency and productivity while working with people, not just replacing people. The biggest difference between cooperative robots and industrial robots is whether they can work with people.

Differences between cooperative and industrial robots:

Cooperative robots are designed to work with people, while industrial robots are designed to operate independently without people. Therefore, the work or intensity of the work performed is different. Cooperative robots perform tasks that may be somewhat dangerous, physically burdensome, or boring for employees to do, and help create safer and more efficient workspaces without excluding tasks related to actual production of products. On the other hand, industrial robots aim to build a manufacturing environment that does not require people, focusing on automating the manufacturing process in the field. In this way, workers do not have to work intensely, and they can reduce the risk of injury from repetitive movements and do more meaningful work.

4. Service robots by industry

4-1. Medical Robot: Medical robot is an intelligent mechanical device that uses robotic technology in the medical field to support various medical services such as surgery, rehabilitation, diagnosis, and patient care.

1)the main types

Surgical robots: A case in point is the Da Vinci robot, which enables minimally invasive surgery, increasing precision, safety, and faster recovery time. It also enables remote surgery, allowing operations to be performed in places where no professional surgeon is present.

Rehabilitation Robots: assist the movement of elderly or disabled patients, assist in treatment exercises, walking training, and monitor their progress carefully.

Diagnostic and laboratory robots: Automate blood tests, pathology tests, and more to improve accuracy and speed, and are also used to transport biological hazards.

Robotic prosthesis: It aids the physical functions lost by the patient with artificial prosthetics and is also equipped with a function to learn through AI.

Hospital Support Robots: move autonomously, relieving medical staff of work, such as food, drug delivery, and sample transportation in the hospital.

technical features

It has high-resolution 3D imaging, precise control, and AI-based automatic judgment capabilities to enable accurate surgery and customized treatment.

Advanced technologies such as patient-customized 3D printing prosthesis production technology and micro robots are leading the development of medical robots.

Medical robots are revolutionizing various medical fields, including improved precision of surgery, rehabilitation support, automation of diagnosis, and efficient patient management, and significantly improving patient care and quality of care.

4-2. Shipping robot: Delivery robots are robots that automatically deliver various items such as food, packages, and food to customers by installing autonomous driving functions.

1)Key Technologies and Service Methods

Most delivery robots avoid obstacles by using sensors and AI, and can be driven indoors and outdoors. The recently commercialized robots have loading boxes that carry out multiple orders at the same time, and deliver products ordered by customers through apps or messengers to designated places. Real-time tracking, notification functions, and remote management through control systems are also provided to increase work efficiency. Some robots can be moved between floors in apartments and other places in conjunction with elevators, allowing them to deliver directly to the "last mile."

2)Case study and application area

RM5 (Robomart): Up to 223kg loaded, 10 individual lockers, multiple orders transportable at once, ready for delivery business in the United States.

Newbility, Mobin: under 500kg loadable, 8 hours drive, overcoming obstacles and applying stair-moving technology.

LG Chloe Subbot: Reduce manpower burden by automating repetitive delivery tasks in hospitals, offices, etc.

Demonstration Project: Delivery experiments and commercialization are underway in hotels, apartment complexes, and urban areas.

3)strengths and limitations

It has the advantage of reducing the cost burden on both restaurant owners and customers because there is no or cheap delivery fee.

You can receive items in front of your house at any time you want without fear of losing them.

People-centric value creation and automation of simple/risk tasks increase social efficiency.

Environmental constraints such as the structure of the interior of the building, and achieving a perfect last mile remains a challenge.

Delivery robots are expected to play a big role in various fields such as automated logistics, non-face-to-face services, and manpower shortages in the future.

4-3. Foodtech Robot: Foodtech Robot is a robot that applies advanced technologies such as artificial intelligence, robotics, and 3D printing across the food industry, and is used in all stages of food production, processing, delivery, and consumption.

1)Definition and Characteristics of Food Tech Robots

Food technology is a compound word of food and technology, and new technologies such as bio, AI, IoT, robots, and 3D printing are applied to the entire food industry.

Food tech robots include cooking robots, serving robots, dishwashing and cleaning robots, last-mile delivery robots, smart farm robots, and more.

Robot chefs are machines that cook automatically and are used in various spaces such as fast food restaurants and restaurants.

The serving robot utilizes autonomous driving technology to automate the provision of meals in restaurants, etc.

2)practical application case

Miso Robotics in the United States develops a cooking robot called Flippy to bake hamburger patties and fry fries.

Japan's Octo-chef is a machine that automatically completes ramen manufacturing in 90 seconds and is installed at airports and major facilities.

Robots that automate the entire process from pizza manufacturing to delivery also appear, and are spreading in various forms such as unmanned restaurants, robot baristas, and unmanned kiosks.

3)Key Effects and Prospects

It has advantages such as reducing labor costs, eliminating labor shortages, strengthening food safety, and improving productivity.

4)Effectiveness of Introduction of Logistics Robots

It contributes to reducing labor costs and improving operational efficiency by reducing manpower dependence.

It can be operated 24 hours a day without rest, helping to solve the shortage of manpower.

Improve the overall efficiency of the logistics process by improving the speed and accuracy of work.

5)domestic and foreign cases

Coupang Daegu fulfillment center utilized more than 1,000 AGVs and sorting bots to significantly reduce the working stage and maximize the efficiency of logistics warehouse operations.

Amazon acquired Kiva Systems to develop its own logistics robots, greatly increasing the efficiency and accuracy of picking operations.

In Korea, large companies such as LG, Bear, and Rainbow

are actively participating in the logistics robot market and providing innovative solutions.

Logistics robots are the core of digital transformation and automation acceleration of the logistics industry, with high market growth and rapid application of various new technologies worldwide

4-4. Guide robot: Guide robot is a robot that guides visitors autonomously to various places such as museums, public institutions, shopping malls, and hospitals and provides services on behalf of people such as providing information, guiding directions, accepting orders, and responding to foreign languages. Autonomous driving, sensor technology, and AI chatbot are applied as core technologies, allowing them to locate and guide themselves even in complex environments.

1)Key Features and Features

Autonomous driving and avoiding obstacles enables safe and smooth movement

Provide real-time Q&A with custom UI and learning chatbot

Provides AR (augmented reality)-based guidance and interactive content

Subtitles and sign language support services for hearing and language impaired persons

Allows you to serve as a guide along with advertising and promotional features

2)Example of a representative guide robot

LG CLOi Guidebot: 150cm size and equipped with sensors such as LiDAR and cameras, conduct customized guidance and advertising in museums, hotels, and public institutions.

It was introduced by various public institutions such as the National Museum of Korea, Gangnam-gu Office, and the National Gongju Museum to guide visitors and support exhibition commentary.

Airstar (Incheon Airport): Commercialized as a destination guide and escort in the airport.

3)industrial significance

Guided robots are solving manpower shortages, improving user experience by providing customized services for visitors, and increasing work efficiency for companies and public institutions. They are rapidly developing in combination with advanced technologies such as AI, sensors, and cloud data.

4-5. Care robot: A care robot is a robot that supports the daily lives of the elderly, patients, persons with disabilities, and children in need of physical and mental care, and is largely equipped with physical assistance, emotional communication, health monitoring, and daily life support functions.

1)Types and functions of care robots

Auxiliary Robot: A robot that helps with physical activities such as supporting this (standing up, walking, etc.), eating, and assisting with bowel movements.

Social Robot: Helps relieve loneliness and depression by supporting emotional communication and social interaction. For example, robots for dementia patients 'Paro' etc.

Integrated care robot: It combines physical assistance and emotional care to provide personalized services.

2)Key Features

Voice recognition and AI conversation features support life such as role and schedule management and medication notification.

Provides conversation and comfort tailored to the user's emotional state with emotional recognition and response functions.

A safety function that automatically notifies a guardian or emergency center in the event of a fall or abnormal movement.

Connecting users' environmental and behavioral perceptions, object recognition, and dialogue with sensors and cameras.

3)a representative case

Domestic products such as "Hyodol" and "Dasom K" are AI care robots with excellent natural conversation and emotion analysis functions to support users' daily lives and respond to emergency situations.

Companion robot dog 'Jenny' and seal-shaped 'Paro' help with emotional stability and loneliness.

It monitors health conditions in real time in conjunction with wearable devices and analyzes the daily patterns of the elderly to detect abnormalities early.

4)The Social Meaning of Care Robots

It is attracting attention as a technology that responds to the growing demand for care with an aging society and solves the shortage of care providers.

It is developing into a multifunctional digital care partner capable of maintaining user autonomy, strengthening safety, and emotional care.

4-6. Patrol Robots: Patrol robots are self-driving robots that are mainly used in security and security fields, and they are responsible for moving around designated areas by themselves, detecting their surroundings, raising alarms and sending notifications to control centers in the event of an abnormal situation. They complement the work of human security guards, and increase operational efficiency and safety with 24-hour unmanned patrols.

1)Key Features

Various sensors (LiDAR, thermal imaging cameras, ultrasound, microphones, etc.) are used to avoid obstacles,

detect fire, detect abnormal noise, and identify intruders.

Based on autonomous driving technology, you can plan and move routes in complex indoor and outdoor environments.

It is equipped with AI-based behavior recognition and threat judgment functions to respond quickly in the event of a dangerous situation.

Situation monitoring and remote control are possible with real-time video and data transmission and reception with the control center, and warning broadcasts can be made if necessary.

Collaborate with security personnel and contribute to eliminating blind spots and improving cost productivity.

2)field of application

Patrol work is carried out in various facilities such as apartment complexes, parks, industrial complexes, hospitals, and military units.

Strengthen safety management of large public spaces and major facilities.

Follow-up management through quick response and record keeping in the event of a dangerous situation.

Patrol robots patrol longer and more efficiently than humans, and can perform stable security tasks without emotional friction.

4-7. Agricultural Robots: Agricultural Robots aim to reduce labor and improve productivity by automating various agricultural tasks such as sowing, transplanting, weed removal, control, harvesting, and transportation. The latest agricultural robots utilize AI, autonomous driving, computer vision, and sensor technology to perform agricultural tasks precisely and efficiently.

1)Major Types and Functions of Agricultural Robots

Sowing and transplanting robots: Plant seeds and seedlings in the right place to help with uniform cultivation.

Weed removal robot: Reduce pesticide use by selecting and removing or controlling only weeds using AI.

Harvest Robots: Recognizing the growth status of crops and harvesting them in a timely manner, specialized robots for each item such as strawberries, apples, and tomatoes are being developed.

Transport and Packaging Robots: Perform automatic transportation and sorting and packaging of harvests.

Autonomous agricultural machinery: GPS, LiDAR-based autonomous tractors or control equipment used for extensive farmland work.

2)Technology and Advantages

It utilizes AI and computer vision to monitor crop conditions in real time and detect pests early.

The autonomous driving function enables accurate movement and work on large farmland.

Along with addressing labor shortages, it contributes to shorter working hours, lower costs, and environmentally friendly agriculture.

It can be operated 24 hours a day, which is effective in maximizing productivity.

Agricultural robots are evolving into advanced ICT convergence technology beyond the automation of existing agricultural machines and are attracting attention as future leaders of agriculture linked to smart farms.

4-8. Rehabilitation Robot: A rehabilitation robot is a robot that aims to restore physical abilities of patients whose physical functions are impaired due to diseases or accidents. It helps patients with movement disorders, such as stroke, cerebral palsy, and spinal cord injury, to effectively recover their walking and upper limb (arm and hand) functions.

1)Types and functions of rehabilitation robots Walking Rehabilitation Robot: It helps patients practice walking patterns that are close to normal repeatedly, and customized treatment is possible by adjusting walking speed, stride, and assistance. Examples include Lokomat, Walkbot, and Morning Walk.

Upper extremity rehabilitation robot: High-intensity upper extremity exercise training is conducted to restore shoulder, arm, and hand functions, and game elements are combined to increase the motivation for treatment and to check the effectiveness through quantitative evaluation. Representative devices include Amadeo, InMotion, and Armeo Power.

Standing and Autonomous Walking Robot: A robot that helps patients who need initial standing training or autonomous walking, including Erigo and Andago.

2)Benefits of Rehabilitation Robot Therapy

High-intensity, repetitive exercise stimulates nerve plasticity in the brain to induce effective functional recovery.

Customized treatment is possible for the patient's condition and recovery stage, and the intensity and frequency of treatment can be adjusted.

Exercise analysis and real-time feedback can maximize treatment effectiveness.

It can motivate patients to treat and train in a safe environment.

3)Domestic Utilization Status

In Korea, rehabilitation hospitals and nursing hospitals have introduced various rehabilitation robots to provide customized step-by-step treatment for patients. For example, Well City Nursing Hospital provides patients with rehabilitation step-by-step treatment through five types of rehabilitation robots (standby training robots, normal

walking robots, autonomous walking robots, walking suit robots, and upper limb training robots). Severance Hospital opened a robot rehabilitation treatment center for the first time in Korea and proceeds with step-by-step systematic treatment.

Rehabilitation robot therapy provides efficient rehabilitation effects, especially for patients such as stroke, spinal cord injury, traumatic brain injury, and Parkinson's disease, and greatly helps patients recover their function quickly and return to daily life.

4-9. Telepresence Robot: It is a combination of the words "tele," which means distance, and "presence," which means attendance, and is a next-generation video conferencing system that takes existing video conferencing to the next level and creates the illusion that you are facing the other person directly through digital displays. Telepresence robots can move dynamically by adding robot technology to them. It is possible to watch while moving freely inside the museum by remotely controlling the robot with a computer or mobile device without having to visit the museum in person. Telepresence robots have been used in hospitals and universities in Korea, but 2024 will be the first time that they have been introduced in museums and art galleries. Through telepresence robots, visitors can not only watch museum exhibitions but also participate in history education and have conversations with docents (exhibition guides). Visitors control the robot remotely and move it freely in the direction they want, and enjoy the exhibits as if they were actually looking at the exhibits through the high-resolution camera installed on the robot. In particular, the biggest advantage is that they can communicate directly with people through robots. Through sound systems such as monitors, speakers, and microphones installed in the robot, visitors can talk with docents and receive exhibition guides.

Existing museum robots were robots that guide basic information, exhibits, and convenience facilities in museums, while telepresence robots can be remotely controlled by users, allowing them to feel on-the-spot even at a long distance, and contributing to communication aspects, showing different characteristics from existing guide robots. Visitors will experience the experience of being in a museum, such as viewing permanent and planned exhibition rooms and answering questions to instructors using this robot.

5. Current Status of the Domestic Robot Industry

Robot businesses by sector: Robot businesses by sector in Korea are largely divided into manufacturing, professional service, personal service, robot parts and software, robot system, robot embedded product, robot related service, etc. Specialized companies are active in each field.

5-1. Classification of the robot industry by sector

Manufacturing robots: for transfer materials, welding, assembly, processing, biotechnology, inspection, etc.

Robots for professional services: Management of business facilities, safety and extreme work, medical care, construction, military use, agriculture, forestry, fishing, leisure and entertainment use

Robots for personal services: Domestic use, personal health care, leisure, entertainment, hobbies, educational use, etc.

Robot parts and software: structural parts, drive parts, sensors and control parts, operating software

Robot systems and embedded products

Robot-related services: Wholesale/retail, restaurant, rental, R&D, facility management, education, social welfare, etc.

Examples of major domestic robot businesses

Robotiz: Powerhouse in Joint Modules and Actuators Development

Hancom Robotics: Educational AI Robots, Service Robots Developed

Future Robot: Specialized in emotional interface robots

Neuromeka: Cooperative Robotics Technology Focus

Robo-Control: Industrial Robot Automation Solutions

T-Robotics: Specialized in Transport Robots, Semiconductors and Display Industries

Luxroboro: Small Modular Robot Platform with Education and IoT Interworking

As such, the domestic robot industry is subdivided in various ways, from manufacturing to service, and while small and medium-sized enterprises are the main companies, companies that develop their own technologies and products are active in each field.

5-2. Robot production status: The production status of the domestic robot industry may be summarized as follows as of 2025.

The Korean robot industry market is worth about W7 trillion in 2025, growing rapidly in the manufacturing, logistics, and smart factory sectors based on the world's top-class robot investment. The production of robots is expected to increase by 24.1% per year from 547,000 units in 2023 to 2.79 million units in 2030.

As of 2019, domestic robot production is about 4.96 trillion won, with manufacturing robot production at the center. Production and sales decreased slightly between 2018 and 2019, but imports showed an increasing trend.

Industrial robots (manufacturing, smart factory), service robots (logistics, medical care, home), and humanoid robots are the main focus, especially in the mobile robot market, accounting for 50-60% of total revenue. Among them, self-driving logistics robots and healthcare robots are representative.

Korea ranks first in the world in robot density per 10,000 workers (1,012 units), and the robot industry is set to transform into a future industry with advanced technologies such as AI and 5G and policy support.

In 2025, the overall robot industry market is officially growing at an annual average of 14-16% in line with the global market growth of 320-325 trillion won, and Korea has a market size of more than 19 trillion won.

In summary, the domestic robot industry production is growing rapidly mainly on robots and service robots for the manufacturing industry, and in particular, the proportion of future-oriented mobile robots and AI convergence service robots production is increasing. Domestic robot production and market size are steadily expanding, and in the global robot industry, Korea is strengthening its competitiveness with very high robot density and technology convergence.

5-3. Robot import status: The following is a summary of the latest information on the import status of domestic robots. According to the annual robot industry survey conducted by the Korea Robot Industry Association, the domestic robot industry is growing rapidly, centering on robots and service robots for manufacturing, and it also includes detailed statistics on the import and export status of single robots and parts. In recent years, imports from the domestic robot industry have reached hundreds of billions of won, showing a slight decline from about W969.4 billion to W918.2 billion as of 2019 and 2020. Robots for manufacturing make up the largest share of imports.

As of 2025, Korea is increasing the proportion of automation in the manufacturing industry, and the density of industrial robots is the highest in the world, with 1,012 robots distributed per 10,000 workers. Technology acquisition and investment, including humanoid robots, are also actively underway, centering on large companies.

In summary, Korea's robot imports are mainly concentrated in manufacturing robots, and the import is large in line with the rapid growth of the domestic industrial and service robot market, and global cooperation and investment are being conducted to secure technology.

5-4. Robotics Export Status: When looking at the status of domestic robot exports, the domestic robot industry's exports as of 2023 amounted to about W1.55 trillion, up 2.3 percent from the previous year. By item, manufacturing robots accounted for the largest share of the total exports with W924.8 billion, followed by robot parts and software with W188 billion and robots for professional services with W71.3 billion.

The U.S. recorded 474.2 billion won in robot exports by country, followed by 264.8 billion won in China and 78.6 billion won in Italy. In particular, many manufacturing robots are exported to the United States, with the highest amount of 375.9 billion won.

In recent years, the industrial robotics sector has seen double-digit growth for the second consecutive year, with export earnings of $240 million in 2024, up 11.5% year-over-year.

As such, Korea's robot exports are steadily growing, centering on robots for the manufacturing industry, and the proportion of exports to major countries such as the United States and China is high.

6. Current Status of Robot Industry by Major Countries

6-1. Korea: Korea's robot industry is highly competitive as of 2023 with the world's fourth largest sales market and the world's first largest robot density. Korea's robot industry sales in 2023 are worth about W5.9 trillion, with small and medium-sized enterprises accounting for 98 percent. Robots for manufacturing account for about half of sales, and the robot market for professional services is also growing rapidly, growing 13.4 percent.

The Korean robot industry began with KAIST's industrial robot development in the 1980s, enacted the world's first "Intelligent Robot Development and Distribution Promotion Act" in 2008, and systematically developed through a five-year national basic plan. In the 4th Basic Plan (2024-2028), the government is promoting joint investment of more than 3 trillion won between the public and private sectors by internalizing the domestic market, strengthening global competitiveness, localizing core components, securing more than 15,000 robot core personnel, and distributing 1 million high-tech robots by 2030.

However, continuous paradigm shift and innovation are required amid complex environmental changes such as solid lock-in effects of technology and patent market structures with advanced countries such as Japan, Germany, and the United States, global supply chain reorganization, digital transformation, demographic changes, and ESG strengthening.

In summary, the Korean robot industry is positioned as a leading industry with international competitiveness under a strong manufacturing-oriented foundation, rapid growth in the service robot sector, and government policy support, but it faces the challenge of actively responding to intensifying global competition.

6-2. U.S.: The U.S. robot industry is lagging behind its competitors in terms of industrial robot penetration and production, and the rate of robot introduction is also low. As of 2022, the U.S. has 285 industrial robots per 10,000 workers in the manufacturing industry, ranking ninth in the world, and the proportion of companies introducing robots is only 1.3% of all industrial companies. In particular, the U.S. has strengths in robot R&D and innovation capabilities, but due to the lack of a large-scale robot production system and industrial ecosystem, robot exports

have structural problems that make up less than a third of imports. The government's policy support, lack of tax benefits, and social concerns about robot introduction are factors that slow the pace of introduction.

However, the number of industrial robots installed in the U.S. is on the rise recently, with about 44,000 installed as of 2023, a 12% increase from the previous year, of which 69% is used in the automobile industry. The North American industrial robot market is expanding to various fields such as healthcare, food and beverage, electronics, aerospace, and agriculture, and is expected to grow by more than 11.5% annually by 2032.

It is pointed out that the U.S. needs multi-layered policies such as tax credits, subsidies, human resources training, and standards to strengthen the national competitiveness of the robot industry. In order to introduce robots and build an industrial ecosystem, more active strategies and support are required compared to competitors such as Japan, Korea, and China.

6-3. China: China's robot industry is the world's largest, and it ranks first globally in both the number of new installations and cumulative operations in the industrial robot market. As of 2023, the number of new industrial robots sold in China was about 276,288, accounting for 51% of the new global sales of industrial robots, and the total number of operations reached 1,755,132, accounting for 41% of the global industrial robots. Robotic density has also increased rapidly to reach the world's third-largest level, and in order to cope with the aging and intensifying competition in the manufacturing industry, industrial robots are being introduced to smart manufacturing.

The Chinese government is fostering the robot industry as a key strategic industry through policies such as 'Made in China 2025', '13th Five-Year Plan' and 'Robot Industry Development Plan (2016~2020)', and is focusing on localizing core components and increasing technology independence. Recently, the next generation of advanced robots such as humanoid robots are also actively investing in research and development and fostering industrial ecosystems. Policy goals suggest that the robot industry will grow by 20% per year on average and more than double the density of robots by 2025, and we are also working on standardization and quality improvement.

In summary, China has emerged as the world's largest robot market and manufacturing automation powerhouse with government-led policy support and active industrial robot introduction, and is rapidly strengthening its global competitiveness in both technology and market share.

6-4. ***Current Status of the Robot Industry in the European Union (EU)***

Within the EU, Germany, Spain, France, and Italy are positioned as centers of advanced robot technology, and the number of advanced manufacturing companies more than doubled from 2009 to 2022. Germany is the largest robot market in Europe, with industrial robots being widely used mainly in automobile manufacturing, and Italy forming the second largest robot market in the machinery and metal industries. Human-Robot Collaboration (HRC) is the main trend in European advanced robot manufacturing, with Germany's KUKA, Switzerland's ABB, and Denmark's Universal Robots leading the robotics market.

The European industrial robot market is worth about $5.8 billion in 2024, and is expected to grow at an annual average growth rate of 15.7% by 2032, reaching $18.2 billion. The demand for robots is increasing in the automobile, food and beverage, and chemical industries, and the demand for industrial robots is increasing further as the number of small and medium-sized enterprises increases.

The EU supports advanced manufacturing robot research and innovation through the Horizon Europe program (operating until 2027) and is pursuing policies to strengthen the competitiveness of each country's high-tech industries, including the German Industry 4.0 and the French France 2030 program. These policies and research support are increasing the competitiveness of the European robot industry.

6-5. Japan: Japan's robot industry is the world's best, accounting for about 45% of the industrial robot market, and manufacturing robots are actively used mainly in the automobile and electronics industries. Major Japanese companies include Yasukawa Electric, Panak, Nachi Fujikoshi, and Fujitsu, which, combined with AI technology, maintain a competitive advantage in precision control and durability of industrial robots. The government is also making large-scale investments in AI and semiconductors through the 'Society 5.0' policy, and is expected to grow at an annual average of about 9.8% from 2025 to 2033.

The manufacturing robot market has a high proportion of the automobile, electronics, and machinery industries, and in particular, Yaskawa Electric is planning to build a new robot factory that can produce up to 8,000 units per month in 2025. The cooperative robot (cobot) market is also growing to solve the aging and labor shortage, and the introduction of robots is expanding in various fields such as the service industry and agriculture, forestry, and fisheries. In the future, automation innovation through the combination of AI technology and 5G technology is expected to be a key driver of the Japanese robot industry.

6-6. Germany: Germany's robot industry has traditionally shown strong competitiveness in the automobile, electronics, and machinery industries, and the robot market sales in 2023 are about $3.15 billion, up 10.1% from the

previous year. The density of industrial robots is the highest in Europe at 415 units per 10,000 workers, and the production of industrial robots in 2023 reached 35,616 units, showing a high level of automation. In particular, the use of industrial robots is remarkable in the automobile industry, and the service robot market has grown rapidly since COVID-19 and is expanding to medical, logistics, and household use. Germany is expected to form a robot market worth about $4.5 billion by 2025. New technologies such as AI and 5G, robot democratization, and innovation such as cooperative robots are also actively underway. However, short-term challenges also exist due to geopolitical uncertainty, intensifying competition in Asia, and dependence on the automobile industry. New companies' innovations, such as modular robots for small and medium-sized enterprises and independent robot operating systems, are also brightening the future of the German robot industry.

7. Humanoid Robot Trend

7-1. Humanoid Robot Concept: Unlike conventional robots that partially replace human movements or reduce labor, they are beings that replace decreasing human beings themselves. It is a robot that replaces the work that humans used in the same space as humans without making necessary investments or environmental maintenance to use robots. It is a robot that performs not only in the medical field such as nursing, but also in place of actions such as eating, toilet, and bath.

7-2. Humanoid Robotics Technology

(1) Human motion reproduction robot:

(2) Mobile suit of quantitative performance measurement: Quantitative performance measurement is a numerical measurement and evaluation of the performance of a particular system, process, or product, and typical examples include production, energy efficiency, sales growth, and cost reduction ratio, which are externalized to the robot's external suit.
(3) Motion Retargeting' Reproduction: Technology to recreate previous features

7-3. *Humanoid Robot Joints*

The leg joints of humanoid robots are designed to mimic the movement and balance of human leg joints, and their main configurations are as follows.

Hip joints (hip joints): typically consist of actuators with 3 degrees of freedom (front and back, left and right, rotation) or higher to enable multi-directional movement and balance. Strong electric motors or hydraulic actuators are used.

Knee joints: Sensors and AI force control technology are applied to move as smoothly and naturally as human knees, making the knee bend and stretch smoothly.

Ankle joints: At least two actuators perform dorsal flexion, low flexion (up and down motion) and inversion, and internal war (left and right tilt) to support balance and adaptability across different terrains.

Toe joint: It is divided into active and passive, and is involved in propulsion and balance. The active type is capable of precise control and the passive type is simple, but it is energy-saving.

Balancing strategies include adjusting the center of mass using the hip joint and fine posture adjustment through the ankle joint, which are combined to implement stable walking.

These leg joint designs aim for lightweight, agility, and precise control while maximally mimicking the complex movements and dynamics of the human leg.

Actuator joint mechanism: The actuator used in the joint mechanism is a driving device that moves the robot's joints, and various actuators are used to drive the robot's joints, mainly in the form of a combination of a motor and a reducer.

7-4. Humanoid Robot Manipulator: A device of a robot that operates similarly to a human arm,
It mainly has several degrees of freedom and is used to hold or move objects.

7-5. Status of humanoid robots by major countries

(1) Korea (K-Humanoid): Korea's humanoid robot industry is rapidly growing to about W3 trillion as of 2025. It proved its technological prowess by winning the 2015 World Humanoid Robotics Competition, but the technological gap has recently widened compared to the U.S. and China. The main challenges are dependence on overseas core components and materials, lack of investment in R&D, and limited commercialization speed.

As Korea has structural environmental strengths such as aging, labor shortage, and demand for automation of manufacturing industries, there is much room for expansion of humanoid robots. The government and industry are focusing on long-term R&D investment, internalization of components, convergence of AI and human-robot interaction technologies, large-scale investment, and strengthening global cooperation. Large companies such as Samsung Electronics and LG Electronics are also preparing to enter the market by acquiring and investing in related companies. However, securing precision sensors, actuators, robot-specific AI technologies, and bulk data remains a challenge.

Humanoid robots are increasingly used in various applications such as medical care, nursing, education, and entertainment, and Korea is expected to significantly close the gap with advanced countries in the 2030s.

(2) U.S.: Summarizing the status of humanoid robots in

2025 in the U.S

The U.S. accounts for about 25% of the global humanoid robot market, and the use of humanoid robots is increasing rapidly in various fields such as healthcare, personal support, research, and customer service. In particular, humanoid robots are playing an important role in medical fields such as nursing for the elderly, rehabilitation treatment, and patient monitoring. In addition, thanks to advances in AI and machine learning technologies, robots are providing more natural human-robot interaction, contributing to the improvement of customer service.

Several robot startups in the United States have built production facilities and have the capacity to produce 12,000 humanoid robots per year, with the goal of mass production of thousands to 10,000 units per year starting in 2025. It plans to start selling to companies in 2026, and is also planning to launch a next-generation model that can produce 100,000 units per month in the long run. Automobile manufacturers are also expanding industrial applications by piloting humanoid robots for parts transportation in factories.

The humanoid robot market in the United States is expected to grow at an annual average rate of 34.2% from 2024 to 2032, and shipments are expected to reach 38,000 units by 2030. Based on the development of aging social response, productivity improvement, and human-robot interaction technology, this market will grow in various fields such as health care, education, service, research, and space exploration.

Leading U.S. humanoid robot companies include Tesla, Nvidia, Boston Dynamics, and Aptronic, which are leading the development of next-generation humanoids through the integration of AI and physical robot technologies.

(3) China: The status of humanoid robots in China can be summarized as a rapidly growing stage as of 2025. China has the largest number of humanoid robot manufacturers in the world and is promoting industrial development through core technology development and localization of high-performance parts. The Chinese government is fostering the robot industry as a national strategic industry through policy support such as the 'Made in China 2025' plan, and plans to use it in various fields such as disaster relief, manufacturing, logistics, and public service by promoting the commercialization of humanoid robots for a long time.

The market size grew from $250 million in 2023 to $390 million in 2024, with an annual average growth rate of 93% expected by 2028. The number of humanoid robots released by Chinese manufacturers has also increased rapidly over the past three years, accounting for 61% of the world's humanoid robots, with one in 2022, four in 2023, and 35 in 2024.

In particular, Chinese companies are actively seeking to enter the global market by promoting a "cost-effectiveness robot" strategy with price competitiveness, and 2025 is considered the first year of mass production. Some companies have already recorded hundreds of production, and the density of robots in China has reached the world's highest level.

Technically, it combines autonomous driving and AI technology to increase the intelligence and utilization of humanoid robots, and 37 of Morgan Stanley's top 100 global humanoid robot companies are competitive enough to be Chinese companies.

However, there are also concerns about misactions, data security, and cost issues in the commercialization process.

In summary, China is rapidly leading the humanoid robot industry in terms of policy, technology, and production capacity, and 2025 is the first year of mass production and the time to expand its influence in the global market.

(4) Japan: Technological Development and Market Growth Japan started developing humanoid robots in the 1970s, and as of 2025, due to the development of AI and artificial intelligence technologies, practical use is accelerating in various industries. In particular, it has secured considerable technology in natural language processing, autonomous driving, and caring robots of humanoid robots, and related markets are rapidly expanding with an annual growth rate of 35.4%.

application by industry

Manufacturing: As a leader in industrial robots, it is actively used for factory automation and production efficiency.

Care and Healthcare: To address the shortage of care workers due to aging, care robots such as AI-based humanoid robots 'AIREC' are being developed and put to practical use, and research is also underway for safe integration with humans in the medical field.

Service industry: In some hotels and cafes, remote controlled or self-driving robots are responsible for customer service.

research and competition

Japan was a leader in the development of humanoid robots in the past, but since the 2010s, it has experienced a temporary stagnation along with a reduction in financial support. However, there is an active movement to secure technological competitiveness thanks to increased investment from the government and private companies and increased global demand, and competition with the United States, China, and Korea is also fierce.

Conclusion

Based on its technology and industrial infrastructure, Japan has maintained a strong position in the global market by

commercializing humanoid robots in various fields such as medical, caring, manufacturing, and service. In addition, more diverse forms of humanoid robots are being developed through the convergence of artificial intelligence and specialization by industry, and Japan is expected to establish itself as the center of the robot industry in the future.

8. Limitations of AI Robots, Service Robots and Humanoid Robots Industry

8-1. *Limitations of AI Robots*

Explained by Morabek's paradox, everyday sensory and motor abilities (walking, visual and auditory perception, etc.) that are easy for humans are very difficult for AI robots. AI is good at calculating and logical tasks, but sensory and motor control in real-world environments is complex and difficult.

The ability to respond to unexpected situations or new environments is limited, and performance degradation is severe outside the specific environment learned.

As the AI judgment process is opaque, there are also problems with decision responsibility and reliability.

8-2. *Limitations of Service Robots*

Hardware makes it difficult to hold things, open doors, and climb stairs, limiting the scope of tasks to be performed.

Robots do not meet consumer expectations due to low completeness of autonomous services due to physical restrictions such as stopping at the entrance of the building or inaccessible access to certain areas.

There is also a lack of ability to express emotions and handle complex situations in human interactions, and there is also a concern of job loss due to job substitution.

There are also technical limitations and lack of standardization in operating system, multi-function driving, and scalability.

8-3. *Limitations of Humanoid Robots*

High initial costs and high-tech constraints make it difficult for small businesses or individuals to access.

Operations are incomplete in unpredictable situations and have limitations in performing precise actions.

Low activity time due to battery capacity limitations and low energy efficiency due to weight and operation complexity.

Technical barriers are large in AI algorithm development, mass data collection, and sensor and actuator precision, and related ecosystems and infrastructure are insufficient in some countries such as Korea.

Robots are much more difficult to balance and control movement than people walking and waking up, making it difficult to implement stable movements.

Economic limitations, lack of investment, and lack of a government support system are also obstacles to development.

As such, sensory and motor abilities, environmental adaptation, interaction, cost and energy, technology infrastructure, and reliability are major limitations for each robot type.

If necessary, we can guide you in more detail on the limitations of each field, related examples, and resolution efforts.

Community demand: The Ulsan regional economy has grown on the basis of three major industries: automobiles, shipbuilding, and petrochemicals, and has established itself as a major industrial city of the national economy. However, the international competitiveness of the main industries is weakening due to the recent deterioration of economic conditions at home and abroad. The sluggish petroleum refining and chemical products continue in manufacturing production, and the automobile sector maintained the previous quarter's level, but the shipbuilding sector is showing slight improvement. Consumer activity in the demand sector has remained weak due to weak consumer sentiment, and in the construction investment sector, construction area and civil engineering construction orders have slowed, while facility investment in the main industry is generally showing a good trend.

In terms of the economy as a whole, the AI robot industry, which emerges as a future industry as a blue ocean at a time when it is necessary to overcome difficult economic conditions and environments, is a strategy to avoid competition by creating new markets rather than existing markets, and it is clear that it can play a key role in discovering unmet demands from domestic and foreign customers and creating and providing new values.

9. Policy implications:

9-1. *Domestic economic environment*

In the recent domestic economy, semiconductor production has continued to increase, and related facility investment and exports have maintained a good trend, but production and exports, excluding semiconductors, are slowing down, construction production continues to decline significantly, and manufacturing production, excluding service and semiconductors, is also slowing. The prolonged slump in product consumption and construction investment has limited economic improvement, and despite the recent political unrest, fluctuations in financial market indicators such as exchange rates and stock prices have remained limited, but the sentiment index of households and businesses has fallen significantly. In other words, economic sentiment has worsened due to the domestic political situation amid growing external uncertainty.

9-2. *Foreign economic environment*

1) U.S.: Stock volatility surged whenever investor sentiment shrank due to the prospect of continued high interest rates in the U.S. and concerns over worsening trade environment, and stocks remained sluggish in the U.S. and a number of emerging economies. Downside risks are believed to be high, with concerns over U.S. protectionism expanding and geopolitical tensions continuing.

2) China: The possibility of further economic stimulus, such as expanding bond issuance and easing monetary policy, is increasing as consumption of major commodities is only on a low rise and imports continue to decline. Although production and exports remain on the rise, economic uncertainty continues due to sluggish real estate investment and concerns over trade conflicts with the United States.

3) EU: The downward pressure on the economy at home and abroad is increasing due to low growth and worsening trade environment in major countries, and the trend of lowering the benchmark interest rate is expected to continue. In Germany, sluggish growth continues due to weak industrial production and investment due to a shift in consumer sentiment.

4) Japan: Mining and manufacturing production increased by 1.4% year-on-year, and we are concerned about the impact of downward pressure due to uncertainties in the overseas economy. The consumption trend index decreased by 0.1% month-on-month, but it is expected to recover gradually. Private investment increased by 8.1% year-on-year, and investment recovery is expected to continue based on solid corporate performance in the future. Exports increased by 3.8% year-on-year, reducing the trade deficit.

Despite this difficult economic environment at home and abroad, the AI robot and humanoid robot industries are continuously growing, and it is expected to grow into an emerging industry of the local economy that leads to high value-added as an alternative industry to replace the three major industries in the local economy in the future.

10. Conclusions and differentiation from previous studies:

AI robots, service robots, and humanoid robots are all innovating various industries and daily lives through the convergence of artificial intelligence and robot technology. Each type has distinct features and values according to its purpose, function, and role in the market.

AI Robot's Conclusion

AI robots are robots that implement autonomous decision-making, learning, and adaptability based on artificial intelligence algorithms. They perform complex tasks in various fields such as industrial automation, medical diagnosis, autonomous driving, and agriculture, and play a role in greatly improving human life and productivity.

Conclusion of service robot

Service robots are robots designed primarily for the purpose of assisting or replacing humans directly. They provide customized services such as cleaning, delivery, guidance, and healthcare in various environments such as hospitals, restaurants, hotels, and homes. Recently, due to the aging population and the increasing demand for non-face-to-face services, the scope of application is continuously expanding.

Conclusion of the Humanoid Robot

Humanoid robots are robots that aim at human-like appearance, motion, and natural interaction with people. They provide human-friendly services in education, guidance, care, and entertainment, and their communication and collaboration capabilities with humans are being studied intensively. Although there are still technological and economic limitations, they have great potential for convergence with human society in the long run.

a comprehensive conclusion

AI robots utilize advanced intelligence to be applied to universal and professional industries, maximizing automation and efficiency.

Service robots are developing in the direction of daily work support and improving the quality of human life.

Humanoid robots are a communication-oriented technology with humans and are expected to play a key role in narrowing the boundaries between humans and machines in future society.

These three areas are complementary and will create important technological and economic value in the future society.

Existing robot research targets ① surgical robots designed for precise surgical operations, ② most industrial robots are fixed in specific locations to perform tasks, and ③ industrial robots that perform only programmed tasks with limited autonomous decision-making capabilities. However, this paper presents a difference in that AI robots with built-in artificial intelligence, ① have the ability to imitate the human body structure, ② have the ability to walk on two feet, ③ can easily adapt to the human living environment, perform various tasks, and ④ humanoid robots that can recognize, learn, and make decisions through advanced AI technology are compared and analyzed, and the impact on the local economy is presented, which can be said that this study has a comparative advantage over existing studies.

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