

A Current Status and Future Prospect of Service Robot Industry

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Abstract Background/Objectives: *The robot industry has been carrying out simple repetitive tasks in the process of industrialization on behalf of human beings. These robots are now used in more complex and diverse areas including intelligence in simple and repetitive tasks. In this study, we describe current trends and developments in robotics industry.*

Methods/Statistical analysis: *Most of the tasks performed by existing robots have been performed on behalf of human beings in the production site in simple and repetitive tasks. In this study, we investigated the technology field which robot is used in more complex and diverse fields including intelligence. The trends of technology development in Japan and the United States, which are representative technologies of robot industrial technology, and future prospect of robotic industry was examined.*

Findings: *Intel's Robotics strategy, which Jimmy has unveiled at Intel, is to build Jimmy as a robot platform and open source, which means that many participants are encouraged to build robots with Jimmy platform. In other words, Intel is expanding its PC or server platform to the robot platform, and it is analyzed that it aims to maintain the leadership of the robot platform in the robot market by making the chipset of semiconductor products such as Intel CPU. From the current and future growth prospects from 2000 to 2025, we can see that the results for the year are higher than expected. Therefore, this development is expected to continue to increase in the future.*

Improvements/Applications: *In this paper, we describe the contents related to robot, which is a representative example of the 4th industry. As the development of artificial intelligence technology is highly likely to proceed rapidly in the future, it is expected that the intelligence of the related robot industry will also change very rapidly*

Keywords: *Robot, Artificial Intelligence, Professional Service, Personal Service, Pepper.*

I. INTRODUCTION

Artificial intelligence is a broad method, algorithm, and technique for operating software in a smart way that looks similar to humans. Lin Parker, director of information and intelligent systems at the National Science Foundation, commented that machine learning, computer vision, natural language processing, robotics and related topics all belong to AI. Artificial intelligence technology adopts the terms mechanical intelligence and computational intelligence. It combines machine learning with machine (computer) and various nonlinear transformation techniques to achieve high

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level abstractions (Deep Learning), which is a set of machine learning algorithms that try to teach the human mind to the machine (computer).

Recently, global IT companies such as Google and Tesla are focusing on developing artificial intelligence technology. In November 2015, Google released an artificial intelligence engine called TensorFlow. In December 2015, Tesla continues to be fiercely competing with major companies to preoccupy the future AI global market, such as establishing 'Open AI', a nonprofit artificial intelligence company jointly with WiCombinater.

In the future, AI technology will be linked to 'IoT (sensor, data acquisition) - wireless communication (transmission) - big data, deep learning (analysis) - artificial intelligence - product reflection'. And can be applied to all industrial sectors [1-4]. The term robot is used to mean being forced to perform human labor instead. Apparently, it looks like the current Android Robot. From a technical point of view, it can be said that it is a clone rather than a modern machine, which is a metallic machine in that it is a biological entity.

It may be surprising to those who have never seen a robot, not in a cartoon or a movie, but there are a lot more robots in the world than we think. There are robots that are very similar in shape to human beings, and some robots imitate animals and insects. There are also some alien-like robots that perform tasks given only by arms without a torso.

The International Federation of Robots (IFR) classifies various types of robots into service robots and industrial robots. The manufacturing robot refers to robots used for manufacturing automation in a manufacturing field, and the service robot refers to all other robots, that is, a robot that provides useful services in a home or a specific area of expertise [3-6].

Manufacturing robots have already been recognized as excellent industrial robots at the production site, and about 60% of service robots are relatively familiar cleaning robots. Most of the rest are entertainment robots, which are more suitable for moving toys than robots. While cleaning robots are one of the greatest types of robots, the problem is that they have a very high percentage of all service robots [7]. Although the personal service robot is intended to provide various services such as housework support, elderly support, rehabilitation support, and education, the fact that the cleaning robot occupies most of the actual robots still makes robots that can be used widely in addition to the cleaning robots. It would be because it did not.

However, many companies, universities, and

research institutes are trying to develop robots that can provide various services. Some are commercialized and sold. Many people are not as attracted as they are willing to pay for the price, but it would not be long before robots would enter our lives if research and development continue.

II. ROBOT INDUSTRY TRENDS

2.1. Japan

In 1986, Honda engineers started building walking robots, and as a result, in 2000, developed ASAMO, one of the most advanced human robots in the world. Asamo is the first walking humanoid robot. The Asamo 2012, 130 cm tall and weighing 48 kg, can travel up to 9 km an hour, run along the circle, and walk on uneven surfaces. You can also jump high and climb stairs. Also, the recently produced Asamo can push carts and feed them to the tray along with the drinks. Figure 1 shows Honda Asamo.

Asamo's hand with multiple fingers can follow a drink from a bottle, twist a stopper, or even handle a paper cup without breaking it. This handsome hand works by using a touch sensor and a force sensor that allow feedback on the robot's information processing device on the palm and fingers to control each finger separately. Object recognition technology based on visual and tactile sensors enables Asamo to work or use sign language.

It should be watched more closely to see if the robot's hand can handle objects of different shapes and sizes, such as paper, cushions and wires, but this is quite different from the joint arms and hands that have no elasticity used in industrial robots. Creating a robot hand that can handle any kind of object freely can be done through creative thinking.



Figure. 1 Honda Asamo

In 2012, SOFTBANK launched a joint development project with Pepper to acquire 80% of Aldebaran Robotics, a French venture company with world-leading technology in the field of humanoid robot development. In June 2014, Softbank launched the Pepper, an artificial intelligence robot. This robot is equipped with an algorithm that grasps the surrounding situation and judges necessary actions autonomously. It is a humanoid robot that can recognize and communicate with the other's feelings. Figure 2 shows Softbank Pepper.

Currently, it is sold at a price of 198,000 yen at the SOFTBANK Mobile store in Japan, but every time a limited edition is released online, it is sold out in one minute and is gaining immense popularity. Through the sensor, it immediately analyzes the external information, predicts the state of endocrine substances such as dopamine and serotonin

in facial expression, and judges whether the emotion of the opponent is positive or negative. Pepper features IBM's Artificial Intelligence Watson to maximize recognition accuracy.

The successful launch of the home-use robot Pepper has also increased demand for businesses. Nestle, the world's largest food company, announced its plans to use 20 pepper shops at its coffee vending factories in Tokyo next month to serve customers and buy 1,000 peppers until next year. Japan's retailers such as UNIQLO, financial institutions and educational institutions are also negotiating the purchase of SOFTBANK and Pepper, and the future of humanoid robots, which robots pour into everyday life, is approaching. SOFTBANK is also expanding its base technology for artificial intelligence technology by acquiring ARM, a UK semiconductor design company.

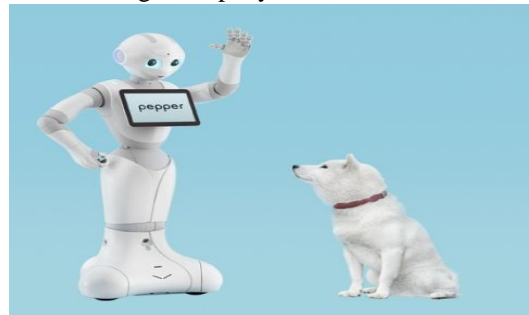


Figure. 2 Softbank Pepper

2.2. United States

Sofia is designed to interact with humans. David Hanson, CEO of Hanson Robotics, who created Sofia, says Sofia is suitable for medical, customer service and education. He became a companion for elderly people in the nursing homes and painted a robot that guides people at large events. It gives the robot a role to coexist with humans and improve the quality of life of people. Sophia is made of humanoids with a human-like appearance for communicating with humans. Humanoid is a compound word of 'human' meaning human and prefix '-oid' meaning 'something like ~', which means a robot with a body structure similar to a human body.

In particular, Sofia invested a lot of technology on her face. Hanson Robotics imitated the facial expression of Sophia so that the robot could interact with people in a friendly way. They pointed out that people faced each other and read and communicate each other's expressions. Sophia's face was modeled on actress Audrey Hepburn and she can express her feelings with over 60 expressions on her face. You can create a variety of facial expressions, such as blinking eyebrows and frowning eyebrows, using artificial intelligence algorithms that are similar to human skin's frubber material. In addition, 3D sensors are attached to the eyes to recognize people, align their eyes and move their heads.

Sophia can communicate with people based on their sympathy through the face. It uses Google's parent company alphabet speech recognition technology. You can answer specific questions and have simple conversations about



pre-defined topics such as weather. Hanson Robotics explains that while in-everyday conversation with Sofia is possible on the spot, in-depth discussion requires learning. Basically it works in a similar way to Chatbots that respond to specific questions or phrases. The input voice information is shared in the cloud network, and the input value and the output value are analyzed by the block chain technique. It was upgraded to be able to walk in January 2018.

A robot looks like a human being, nods his eyes, nods his head, makes faces and naturally communicates with people. In itself Sofia attracted attention. People were enthusiastic and the media's attention was pouring. Sofia has appeared in various media such as <CBS 60min>, <Good Morning Britain>, <CNBC>, <Forbes>, <Mashable>, <New York Times>, <Wall Street Journal>, <Guardian>. Sophia has been culturally consumed as a symbol of artificial intelligence and robots, beyond interviews and appearing in news media and TV shows. He appeared on cover magazine as a cover model, and appeared in movies and music videos.

In October 2017, Saudi Arabia became the first robot to receive citizenship and became a hot topic[9]. The worry about the coexistence of humans and robots is the moment that came out of the film. But criticism of Saudi Arabia's granting of citizenship to Sophia is trivial. Details of citizenship are not disclosed, and it is pointed out that the show is just for the promotion of the event. The news of citizenship for Sofia was announced at the Future Investment Initiative at the International Investment Conference in Saudi Arabia. It is also criticized for the fact that robots that have the appearance of women are better treated than Saudi Arabian women. The appearance of Sofia at the event is due to the distance from the existing Saudi Arabian women's dress. Saudi Arabian women are vulnerable to human rights when they are accompanied by a male guardian. In the end, this event is an evaluation of the purpose of investment inducement rather than a genuine concern about the rights of robot. Figure 3 shows Sophia.

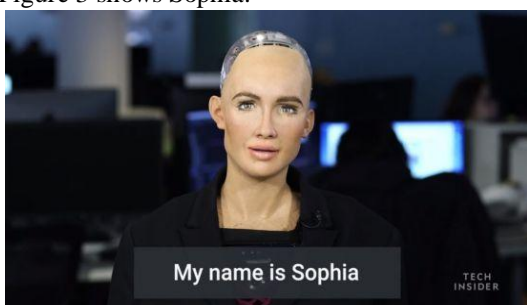


Figure. 3Self-introduction Sofia (Source: Business Insider)

In addition, Sofia has also appeared as a panelist at the United Nations Economic and Social Council (ECOSOC). Sofia, who attended the ECOSOC regular meeting in October 2017 at the United Nations Headquarters in New York, USA, was noticed the unanswered answers to the questions of UN Secretary General Amina Mohammed. Sophia's remarks were the most noteworthy among the speeches at the United Nations stage in 2017. Sophia's UN remarks video posted on YouTube has now passed 2.2 million views. I visited Korea in January 2018 and got a great

response. As such, Sofia has become a cultural symbol of the robotics system and has gained some authority, receiving media and people's attention.

There are also many criticisms of the media's customary attitude toward Sofia as a living creature[8]. "Sophia has neither feelings nor opinions, she does not understand what she is talking about, and she is just a puppet," said Professor Yan Lu Kun, a professor at NYU University on Facebook. Sophia does not have intellectual ability. Experts reviewing Sofia's open-source code say it's appropriate to classify Sofia as a face-to-face chatbots.

Bob Gorbelt, senior researcher at Hanson Robotics, who created Sofia, admits that Sofia does not have the same intelligence as humans. But he claims that Sofia plays a role in making human-level AI look forward. In other words, exaggerated expectations about Sophia are spreading optimism about AI, which makes a positive contribution to AI research and industrial development. Also, most of the conversations in Sofia come from a simple decision tree that says Y as if it were used in chatbots, but it is technically meaningful because it interacts with the robot's movements, including facial expressions. In terms of dynamic integration, such as cognition, behavior, and dialogue, advanced technology is used. In a nutshell, Sofia is designed to recognize people, listen to what he or she is saying, and create an appropriate look.

Intel is launching its robotic platform in the Intel Developer Forum at the Intel Developer Forum, Intel Developer Forum, by unveiling the Jimmy, a bipedal humanoid robot for consumers. The size and weight of the Intel Jimmy is 8.5cm and 6kg, and you can assemble yourself by purchasing each product individually and referring to the Intel Guidebook. In the case of the appearance, 3D printer is customized and characterization of each user is possible. Figure 4 shows Intel Jimmy.



Figure. 4Intel Jimmy (source: [10])

Intel's Jimmy Robot program itself is open source based and has the advantage that users can program freely. Therefore, if you enter a program for cleaning, it becomes a cleaning robot, and when a program for cooking is input, it becomes a good cooking helper robot. Jimmy can shake hands or sing through various programming, and send messages to the social network service SNS. Intel's robotic platform makes it unrivaled in usability. Jimmy's release price is set at \$ 16,000.

Intel's Jimmy's public strategy is to build Jimmy as a robot platform and make it open source, which means that many participants are



encouraged to build robots with Jimmy platform. In other words, Intel is expanding its PC or server platform to the robot platform, and it is analyzed that it aims to maintain the leadership of the robot platform in the robot market by making the chipset of semiconductor products such as Intel CPU.

GROWTH PROSPECTS OF SERVICE ROBOT

Let's look at the growth prospects of the robot industry from 2000 to 2025 with reference to Figure 5 showing current and future growth prospects[11]. The overall facts viewed from the picture show that the yearly results are higher than expected. Therefore, this development is expected to continue to increase in the future.

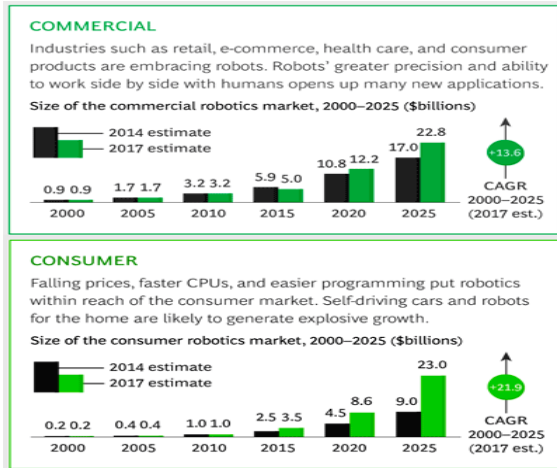


Figure. 5Market Trend(2000~2025) (source: BCG)

Sales of Professional Service Robot are projected to increase by 12% in 2017 to \$ 5.2 billion. The International Federation of Robotics (IFR) estimates that the service robot market will grow by 20-25% on average between 2018 and 2020."From a value perspective, the cumulative market for professional service robots in 2018-2020 will reach \$ 27 billion," said Gudrun Litzenberger, IFR Secretary General. "The robots for medical, logistics and field service It will greatly contribute to growth." At the same time, the personal service robot sector supporting human beings is growing rapidly. Vacuuming, lawn mowers and window cleaning robots are expected to reach \$ 11 billion between 2018 and 2020. Table 1 describes service robot growth trend.

"Robots are growing demand not only in manufacturing but also in everyday environments," says Martin Hagele of the IFR Services Robot Group. "The growing interest in Robotics has led to increased participation in new start-ups. Notable part is that 29% of all robots are service robotics start-ups. The technological diversity of start-ups is also an opportunity for large companies to reach the market with minimal investment. In other words, large companies are increasing their investments in the robotics market by acquiring start-ups.

Table 1: Service Robot Growth Trend

	Professional service robot			Home service robot		
	Number of sales	Growth rate (%)	Sales amount (unit: billion \$)	Number of sales	Growth rate (%)	Sales amount (unit: billion \$)
2015	48,016	-	45	5,400,000	-	23
2016	59,706	24	47	6,700,000	24	26
2017	79,000	32	52	6,700,000	-	26
2018~2020	397,000	20~25	190	32,400,000	30~35	113

III. CONCLUSION

Our society has passed through the tertiary industrial revolution and is now in the era of the fourth industrial revolution. The 4th Industrial Revolution is fundamentally converged with ICT technology, which essentially includes intelligence information, and various smart machines based on Internet technology are examples.

In this study, we describe the contents related to robot, which is a representative example of the 4th industry. The robots industry is changing from efforts to include 'intelligence' in various fields starting from simple manufacturing process machine robots that have been operated in various industrial plants. The present situation of the various humanoid robots including Sofia, which is a representative humanoid robot, and future development directions were discussed.

As the development of artificial intelligence technology is highly likely to proceed rapidly in the future, it is expected that the intelligence of the related robot industry will also change very rapidly.

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