The Market Environment of Robotics and Initiatives of the Robot Division

Yasuhiko Hashimoto
Managing Executive Officer
General Manager, Robot Division, Precision Machinery Company

Introduction

For the 50 years since the launch of its industrial robot business in June 1968, Kawasaki Heavy Industries (KHI) has contributed to the advancement of industrialized society by offering robot system solutions.

Social expectations toward robots have changed over time from their initial mission to save manpower and free humans from hostile environments and heavy labor. Today, they are expected to carry out advanced maneuvers as important tools for ensuring high quality.

KHI produces robots that measure up to such expectations through the tireless development of technologies and products. This article provides an overview of the robotics market before describing the technologies and products deployed by KHI in its core business, as well as the company's initiatives with a view to future business expansion.

1 The robotics market environment

(1) Industrial robotics market

Figure 1 shows the actual and forecast annual sales of industrial robots. The dynamic growth of the market over the last few years is clear, with annual sales reaching 250,000 units in 2015. Defying the ongoing global economic uncertainties, growth is expected to continue and to achieve an annual sale of 410,000 robots by 2019.

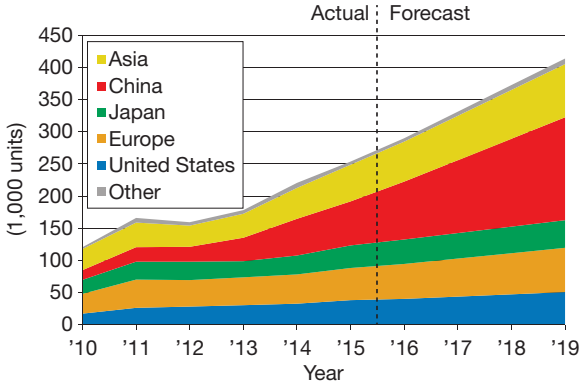


Fig. 1 Actual and estimated global sales of industrial robots
Source: IFR World Robotics 2016

Marked growth is noted in the Chinese market, although sales are growing in every other region as well. Indeed, China is driving the robotics market with a sales growth rate that is more than double that of other regions.

The current growth is primarily due to the Chinese drive toward automation in response to labor shortages and surging wages caused by demographic decline. Another boost is given by the policies of countries seeking to strengthen the international competitiveness of their manufacturing. Examples are Made in China 2025 and Japan's Robot Strategy.

(2) Broadening market

The burgeoning robotics market is also a result of the widening application of robots.

In the past, robots were developing mainly in the automobile industry. Recently, demand is on the rise in other industries. Electric and electronic industries now have the second largest demand after the automobile industry. Their application now extends across metal, machinery, and housewares—even to food. Today's extensive robotics market is the result of new technologies that have expanded the application of robots to address needs in various industries.

In other words, using robots in a wider range of fields is essential to achieving further market growth. There remain many industries without much advancement in automation with robots. The robotic market can be expanded by continuously offering the expected automation solutions in respective industries, which in turn can make positive social contributions.

2 Deployment of KHI's technologies and products

KHI sells various products as a manufacturer of industrial robots. The lineup includes a portable model with a payload of 3 kg, vertical articulated robots with a payload up to 1,500 kg, and various types of clean robots. In combination with high-performance controllers, they cater to a wide range of automation needs.

Using robots in a wider range of fields was pointed out in the previous section as the key task for expanding the robotics market. Many initiatives are taken today in our core business to expand the application of robots. This section presents the latest deployment of KHI's technologies and products.

(1) Automobile assembly

Robots are in much demand for spot welding. A large share in the sales of these robots employed in large quantity entails intense competition among robot manufacturers.

In this area of application, KHI proposes the streamlining of spot welding line by dense installation and joining methods in order to make car body structures of the next generation. These initiatives are described below.

(i) Dense installation

The number of welding spots per process in spot welding car bodies can be increased by employing a greater number of robots. Such dense installation reduces the number of processes and shortens the production line, which significantly benefits customers by holding down capital investment and cutting line operation costs.

The BX Series by KHI caters to such needs. Necessary cables and hoses for welding guns are completely built into these slim robots designed to reduce installation space. Built-in cables reduce the interference area around the upper arm. The slim waist means robots take up less space. Customers can construct a dense installation and highly efficient spot welding system as shown in **Figure 2** by selecting the right arm for their intended purposes from among the BX Series' rich lineup.

KHI is also developing a support tool to facilitate dense robot installation. Multiple robots installed in one process complicates things as their relative positions and allocation of welding spots must be taken into consideration. The ongoing development of our dense installation simulator is intended for performing such complex tasks and provide quality options.

(ii) Friction spot joining (FSJ)

FSJ, which stands for friction spot joining, is a unique technology developed by KHI to join metals with friction heat instead of resistance welding. Commercial application has already begun with the joining of aluminum alloys. Our robot systems have been introduced in automobile assembly processes, and many other places.

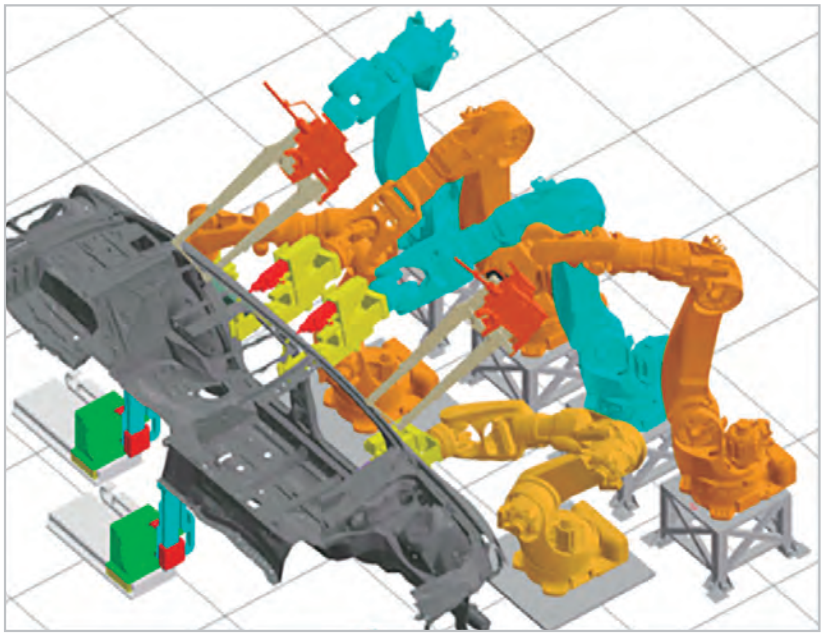


Fig. 2 Example of dense installation (6 BX Series robots on one side)

Presently, KHI is developing technologies for joining ultrahigh-tensile steels and two different materials. Prompted by environmental issues, the automobile industry is pursuing lighter car bodies through wider application of ultrahigh-tensile steel and the use of multiple materials. Because the joining of such steel or materials is very difficult, new methods are being pursued to ensure the necessary strength and productivity.

KHI offers the FSJ robot system (see **Figure 3**) as the company develops different joining processes adapted for different kinds of materials.

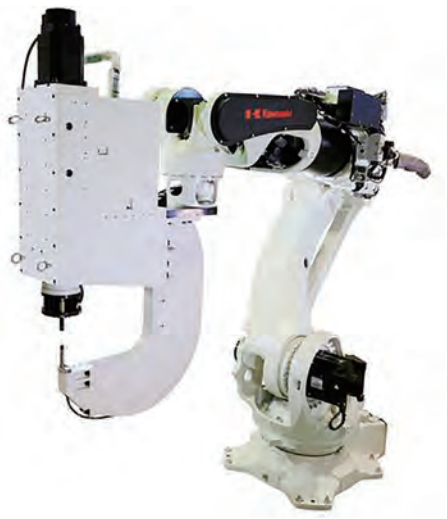


Fig. 3 FSJ robot system

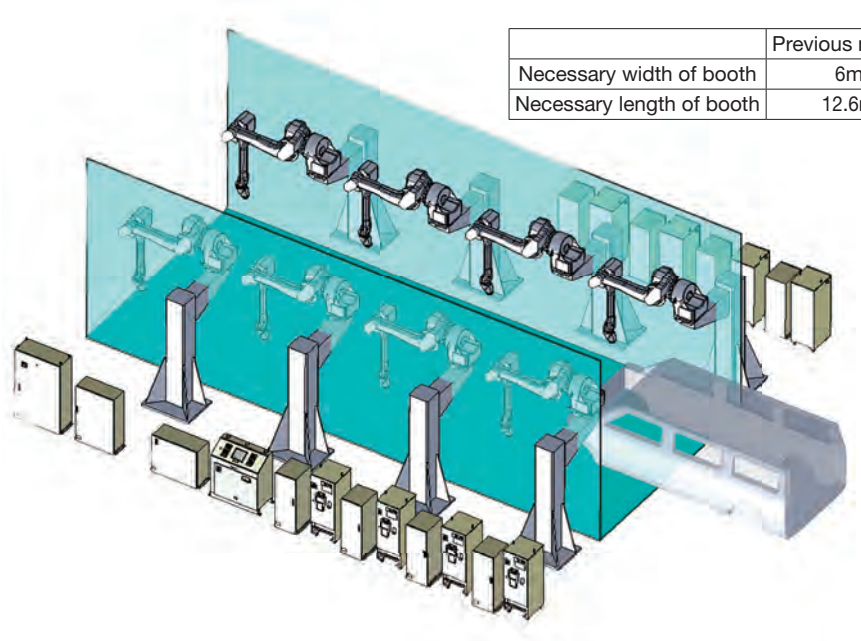
(2) Painting

Painting is a tough, messy, and dangerous task that should be performed by robots. KHI boasts the might of its system engineering built on its wealth of experience. It provides painting systems that can perform various types of jobs.

Special efforts are being made to provide a compact painting booth. The intake and exhaust of a painting booth requires the greatest amount of energy in the painting process. The downsizing of the booth brings significant benefits in reduced energy costs for customers. The KJ264 is a robot designed for automobile painting with a smaller booth by pursuing light weight, slim body, and better maintainability. The interval between robots along the production line and the interference area around the booth wall can be reduced by installing the robots on a wall or on a shelf. In the case of painting an exterior panel of a car, the robot can save up to about 35% of booth area compared to our conventional models (**Figure 4**).

(3) Semiconductors

A clean robot is integrated into a semiconductor manufacturing system for carrying wafers in the system. Since its full-scale entry into this area in 1997, KHI has been developing clean robots that are compatible with various systems, and this is what made it possible to win the top market share.



	Previous models	KJ264
Necessary width of booth	6m	4.5m
Necessary length of booth	12.6m	10.9m

Fig. 4 Dense installation layout for exterior panel painting with the KJ264

† The fast, high-precision transfer system achieved the smallest and lightest robot of industry leading without relying on a travel unit. Power consumption was reduced by roughly 40% compared to previous models.

Figure 5 presents the NT Series, or horizontal articulated robots that form the core of our lineup of clean robots. The greatest advantage this series is that it offers access to all EFEMs* with two to four FOUPs** without using a linear axis. Such robots are employed as common platforms to build product packages with hands and sensors to meet the diverse and individual handling needs of customers.

The design concept for these robots is effectively applied in other models. Products following the NT Series inherited arms with a compact outline and a wide operating range that achieve fast and highly precise transfers. High added value originally derived from the NT Series, such as automatic instructions, self-diagnosis, and collision detection, have also received acclaim from customers.

*EFEM: A module for passing objects from one process to another inside semiconductor manufacturing equipment
**FOUP: An enclosure for wafer transfer

(4) Robot controllers

The controller plays a major role in the effort to broaden the application of robots into new areas. Robots communicate with surrounding devices and operators based on the software implemented in their controllers to perform necessary maneuvers. Application of robots can be broadened when the functions customers need are continuously implemented in controllers in the forms of device interface and software.

KHI's controllers employ the latest hardware technologies to make this happen. The latest high-speed CPUs perform fast processing of increasingly complex software to achieve multiple functions and high performance. In addition, compatibility with fieldbus, fast ethernet, Bluetooth, and so forth has made it possible to construct systems according to customer needs, and to provide new human-machine interfaces such as control systems using tablets.

Figure 6 shows the latest controllers commercialized

Fig. 5 NT Series

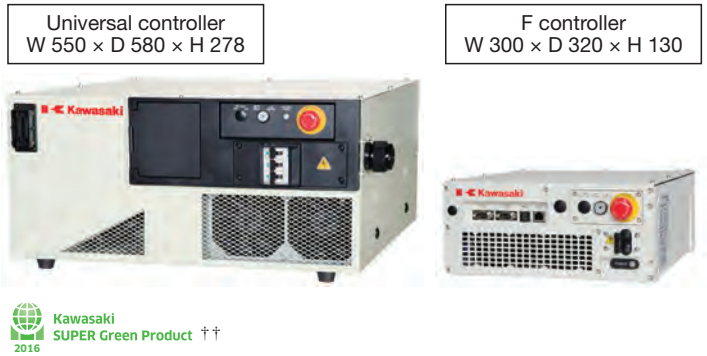


Fig. 6 New controller (Japanese specifications)

†† The functional safety technology significantly reduced electric components needed in the drive circuit. This is the smallest and lightest controller for robots with a payload between 6 and 500 kg.

between 2016 and 2017. Customers highly appreciate that these features are packaged in the smallest bodies among equivalent products.

3 Initiatives with an eye toward the future

The robotics market can only expand through the launching of new technologies in promising areas. The market is giving attention to the application of IoT technologies, as well as cooperative robots and human-cooperative robots that comply with revised safety standards. Many rigorous trials are being made.

KHI also believes these technologies hold the key for the future and thus engages in various initiatives. This chapter describes services we offer with the effective use of IoT technologies, the launch of duAro as a dual-arm SCARA robot for working with people, and our initiatives with medical robots in an entirely new field beyond industrial robots.

(1) Services with effective application of IoT technologies

Various attempts are made in the industrial world of today to effectively use IoT technologies to enhance productivity and competitiveness. By connecting things through the internet, manufacturing is expected to undergo a major change by the fusion with information analysis.

KHI employs IoT technologies in its maintenance services for robots. Elimination of downtime of robotic equipment and reduction of life-cycle costs are major concerns for customers. KHI's TREND Manager caters to these needs by remotely monitoring and predicting the failures of operating robots through the internet, which is offered as a function of our advanced maintenance service called K-COMMIT.

TREND Manager monitors the conditions of robots in operation on a real-time basis to predict possible failures. The conditions of robots are quantified and managed for analysis along with other inspection results to provide necessary information for determining the optimal maintenance cycle and activities.

(2) Collaborative Dual-arm SCARA Robot duAro

According to the revision of ISO standards established for robot safety, various robots are being proposed to work or collaborate with humans. Instead of demanding complete automation by robots, the new attempts seek to enhance productivity by letting humans and robots share the workspace and jobs as they perform tasks each of them are better at.

Toward this end, KHI has developed duAro, a dual-arm SCARA robot designed to work with people, to propose new solutions (**Figure 7**). This human-sized dual-arm robot (designed based on the concepts of "easy to use" and "cooperation and collaboration between humans and robots") can easily take over tasks performed by humans.

The arms of duAro are mounted on a wheeled base with a built-in controller. The robot can be introduced to a workspace to replace a worker without altering the existing production line. The direct teaching functionality and easy operation with a tablet can minimize preparation time from installation to operation, thus quickly building a cooperative

Fig. 7 Collaborative Dual-arm SCARA Robot duAro

††† Peripheral devices were simplified by the safety function that enables the robot to work with humans and the flexibility owing to the dual arms and concerted movement. The time it takes to begin use of the robot was significantly shortened by the simplicity of its installation.

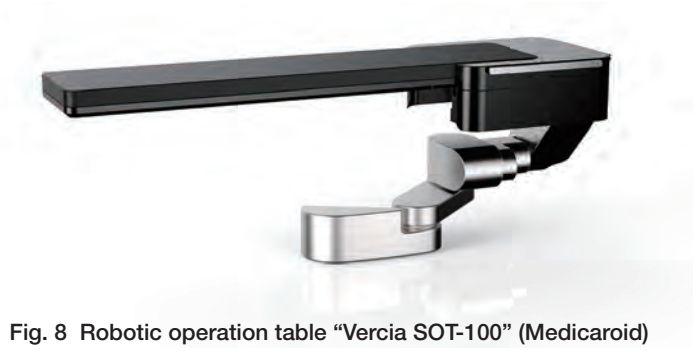


Fig. 8 Robotic operation table “Vercia SOT-100” (Medicaroid)

Fig. 9 Illustration of a surgery assistant robot

production line for the robot and humans.

The ease in instruction and adjustment needed for the installation and operation of duAro lowers the hurdle for customers to introduce the robot. The robot is expected to be effective in applications where people used to be hesitant to use robots, for example, handling of products with short life cycles, seasonal products, and other products with great fluctuation in demand.

KHI considers cooperation and collaboration crucial for meeting social demands. The duAro is a breakthrough for the company to engage in further research to develop cooperation and collaboration technologies, and thereby widen the range of fields in which robots are used.

(3) Venturing to develop medical robots

KHI is also developing medical robots to meet the needs of the times. In 2013, Medicaroid Corporation was established jointly with Sysmex Corporation to engage in the medical robot business to underpin Japan’s aging society.

Commercialization is sought mainly with two types of products.

The first type is called applied robots, which is made by applying the technologies of industrial robots. In fact, many robot technologies can be applied to medical purposes. These technologies can make significant contributions to the advancement of medicine, provided that they meet actual needs. The hybrid robotic operating table commercialized for use in operating rooms in fiscal year 2016 is one such example (**Figure 8**). Technologies from industrial robots are applied to the drive mechanism and motion control so that the posture and position of a patient can be freely set.

Another type is surgery assistant robots (**Figure 9**). They reduce the burden on surgeons involved in maneuvering forceps, endoscopes, and other instruments during surgeries. The burden on patients is also alleviated by pursuing shorter operation times. Toward this end, a highly safe mechanism to precisely reproduce the skill and feel of a surgeon is necessary, along with an adequate control and maneuvering system. Development is underway to commercialize such robots in 2019.

Conclusion

Until now, the development of the robotics market was driven by industrial robots designed to completely replace humans. The commercial application of new technologies epitomized by cooperation and collaboration between humans and robots promises further advancement. KHI will steadily pursue the development of such technologies to continuously respond to the needs of customers and our society.