New Possibilities for Japan's Robot Industry

Summary
The Japanese robot industry is projected to exceed six trillion yen in sales in 2025. Amidst growing demand for cutting-edge industrial robots, Japanese producers are working to strengthen their competitiveness in service robots, where they have made major advances in practical applications. The Japanese robot industry will continue to advance, and increasingly collaborate with cutting-edge component manufacturers, while also engaging in more international alliances.

Six Trillion Yen Market by 2025

The Japanese robot industry began in the late 1960s and had developed numerous practical applications by the 1970s. The year 1980 is considered the commercial start of high-tech robots. The market grew thereafter, although the collapse of Japan's asset-inflated economic bubble and the shift of production (primarily consumer electronics) overseas slowed growth in domestic demand in the 1990s. Nevertheless, the Japanese economy gradually recovered and began to grow again from 2003, and robot shipments (including exports) climbed to 576.7 billion yen in 2004.

By the end of 2004, 356,500 industrial robots were operating in Japan, the largest number in the world. The United States was a distant second with 122,000, underscoring the conspicuous inroads made by Japanese industrial robots. Between 40 and 50 percent of shipment value is exported, making Japan the world leader in exports as well.

As detailed in *N Report – Toward a New Industrial Structure*, issued by the Ministry of Economy, Trade and Industry in May 2004, the Japanese government has targeted robots as a key industry for promotion. The ministry's Next-Generation Robot Vision Panel compiled a report in April 2004 projecting strong growth from about 1.8 trillion yen in 2010 to 6.2 trillion yen in 2025.

Killer Applications Hold the Key

The robot industry also includes non-industrial service robots, a field where Japan lags behind Europe and North America. According to *Comparisons in International Competitive Strength by Robot Application Field*, a collection of opinions from robot experts in industry, government and academia compiled by the Japan Robot Association (JRA), Japan is competitive in three major areas: industrial robots, construction/civil engineering robots and entertainment robots. By comparison, Western robots are strong in the fields of aerospace, nuclear power, entertainment, marine applications, exploration, healthcare, agriculture and livestock.

JRA Administration Department General Manager Shigeaki Yanai explains the reasons for this situation: "For medical treatment, nuclear power and other niche markets, replacements are not needed every year. These products are highly specialized, order-made models for small markets. Japan is not strong in this area. We have the right technology, but we lag behind the competition in software and networking know-how."

Service robots clearly differ from their industrial-use counterparts in many ways. They are highly mobile, seldom used for repetitive work and are becoming increasingly common in everyday life. Safety is a crucial issue for robots that interact with people. For example, the motions required to go up and down stairs are simple enough for people, but pose an extremely difficult challenge for

robots. Similarly, while robots are adept at accurate repetition, they have only limited powers of judgment when different movements must be performed randomly.

On this point, Dai Akimoto, the director of Robot Business Promotion for Strategic Business Development in SGI Japan, Ltd., a company developing unique robot projects, believes that strengthened applications are the key to success. "In Japan, there is a focus on hardware design, with a tendency for companies to create robots in various configurations. However, if the application fails to achieve the desired degree of accuracy, then you just have a robot built for a specific configuration, rather than a specific application. For the next generation of robots, we need to think more in terms of specific applications."

As a case in point, Japan is the world leader in developing humanoid robots, such as Honda Motor Company's "Asimo." Nevertheless, these charismatic robots remain ambiguous at best in terms of what they actually do. Failing to clarify this part of the equation will make it hard to inspire demand. JRA's Yanai also echoes the view that to expand the market for service robots, killer applications are needed to stimulate demand.

Surgical Robots Developed with U.S. Partner

Some companies are aggressively commercializing robots. One example is optical equipment manufacturer Olympus Corporation. Together with Intuitive Surgical, Inc. (IS) of the U.S., Olympus developed the Da Vinci ultrasonic coagulation surgical scissors, the world's first ultrasonic device for endoscopic surgery. In 2003, Olympus developed a 3D/2D imager for an IS-produced robotic endoscopic surgery system. The imager enables surgeons to view the internal body in 3D and operate the endoscope with depth perception, which makes it easier to perform suturing or other delicate maneuvers. The imager can also be switched easily to a 2D wide-angle view to show the positional relationship between the forceps and the target.

"At Olympus, we developed a surgical robot about six years ago and demonstrated it at an academic conference. The timing was a bit early, though, and that particular robot was never commercialized. The project with IS went ahead after they asked us to put our technology to use," relates Shuichi Takayama, head of the Olympus R&D Planning Division.

Olympus also participates in the Medical Engineering Technology Industrial Strategy Consortium, an alliance among industry, government and academia to make the Japanese medical device industry more competitive internationally in terms of developing new equipment. Takayama heads a committee devoted to one of the consortium's core themes, which is developing minimally invasive medical devices that combine high-performance surgical robots with imaging technology.

Endoscopic surgery is much less invasive than conventional abdominal surgical operations. Treatment and hospitalization periods are shorter, and costs are lower. Conversely, visibility during endoscopic surgery is limited and surgical procedures are performed by remote control. This requires tremendous powers of concentration from surgeons, and places great stress on them. But robotics can lower the stress by automating the work and making movements more accurate. For example, a system can be set to move the forceps by only one centimeter when the physician moves the robot arm 10 centimeters. More precision will help to lower the risk of injuring body tissue surrounding the target, and thereby reduce the burden on surgeons.

Akira Suzuki, the general manager of the Research Department of Olympus Medical Systems Corp., says, "In actual surgery, sometimes the surgeon will want to switch from a robotic device to traditional abdominal surgery, but this can lead to problems. For example, the large size of many robots available at present makes it difficult to quickly transition from the robotic device to the surgeon's hands, so this leaves a lot to be resolved. Nonetheless, the role robots can play in the operating room will become more important in the future."

Another drawback of robots is their inability to convey tactile sensations when they touch an affected area. Also, the Japanese government's standards for medical devices are quite demanding, requiring substantial time to obtain approval as medical devices. This is another issue to be overcome in the commercialization of surgical robots.

Unique Mannequin Robots

SGI Japan is also working on developing new applications for robots, such as the mannequin-type robot known as Palette. Developed jointly with robot designer Tatsuya Matsui, director of Flower Robotics, Palette uses motion-capture technology to memorize several dozen human poses, such as those used by fashion supermodels, and it also has sensors to detect and respond people. Applications include fashion show windows and other displays requiring mannequins. Palette can also be equipped to sense the number of people entering a store and their movements once inside, which can be useful for both marketing and security.

"We don't claim that Palette is state-of-the-art technology. However, since we build products based on market needs, we are confident in what we can do. We already have several proposals for investment, mass production, sales and other activities. Our products tend to receive higher evaluations in Europe, where importance is placed on performance," related SGI Japan Director Akimoto.

SGI Japan has also developed the "BlackShip" platform to support robot development, with sales now getting off the ground. The platform consists of a four-wheeled chassis, battery, sample software and other components. According to the company, corporate or university robot researchers will be able to concentrate on application development and other essential research themes without the need to spend time developing basic hardware or software. BlackShip is actually based on the FUMA rescue robot jointly developed by SGI Japan and the University of Electro-Communications.

Vast Component Industry

There are areas of the service robot field in which Japan can hold its own against the West. The *N Report – Toward* a *New Industrial Structure* defines the robot field as a vertically linked industry comprised of systems that integrate machinery, electronics, information communications, materials and other technologies. In the process of integrating such technologies, Japan — with its highly developed component industry — enjoys certain advantages in areas such as miniaturization, weight reduction and production engineering. Japanese technology and expertise developed for industrial robots should be applicable to service robots.

The Ministry of Economy, Trade and Industry is promoting the 21st Century Robot Challenge Program with the aim of developing robotics as a leading industry by supporting R&D for existing robotic systems. Current activities include, for example, projects to develop a shared platform, and practical applications for next-generation robots and both human-friendly and supportive robots. Also promoting a wide range of robot-related projects are the Ministry of Internal Affairs and Communications, the Ministry of Education, Culture, Sports, Science and Technology, and the Ministry of Land, Infrastructure and Transport. According to a JRA study, there are currently some 130 Japanese robot manufacturers with proven production expertise, underscoring the high level of interest in robotics in both the public and private sectors.

Clearly, there is ample potential for the Japanese robot industry to continue to grow and advance. But continued success will require stronger utilization of available advantages, and the aggressive formation of international alliances to adapt foreign technology and products.

References:

SGI Japan. Ltd.
http://www.sgi.com

OLYMPUS CORPORATION
http://www.olympus.co.jp

OLYMPUS MEDICAL SYSTEMS CORP.

JAPAN ROBOT ASSOCIATION
http://www.jara.jp