Tsukuba City Aims at "Robot Town"

By Kunitoshi TOYODA

PHOTO 1
Office of CYBERDYNE Inc. in Tsukuba City, Ibaraki Prefecture

Tsukuba City, Ibaraki Prefecture, is a provincial city with a 200,000-strong population. The city is located about 50 km northeast of Tokyo. At the heart of the city lies Tsukuba Science City inhabited by the brains of Japan – 13,000 researchers, 5,600 of them with doctorates. The science city is home to the University of Tsukuba and a number of public research institutions such as the National Institute of Advanced Industrial Science and Technology (NIAIST), the Japan Aerospace Exploration Agency (JAXA) and the Public Works Research Institute. Aiming at a "Robot Town," Tsukuba City is bringing together the industry, academia and government sectors to create robots useful to society.

The city was traditionally receptive to robots, having hosted an international science and technology exposition in 1985, "TSUKUBA EXPO '85," in which the world's first robot shows were staged with 50 robots of 20 different types performing. The city has since become a world-class robot research and development complex with facilities ranging from major corporate research institutions specialized in motors and other robot components to robotics-related start-ups.

Robot Suit for Aiding Physical Motion

CYBERDYNE Inc., an offshoot of the University of Tsukuba, stands out among Tsukuba's robot start-ups *(Photo 1)*. The company was set up in June 2004 to make use of research results by Professor Yoshiyuki Sankai of the university's Graduate School of Systems and Information Engineering. Sankai doubles as CYBERDYNE CEO.

Sankai was studying a new area called "Cybernics" at the University of Tsukuba. An unheard-of amalgamation of robotics, ergonomics and information technology, Cybernics aims at enhancing and complementing human capabilities with technology. When Sankai advocated the new academic field for the first time, however, it was hardly accepted with open arms. "They used to say it was an entry in the 'others' area," he said.

Of all research results achieved by Sankai, "Robot Suit HAL (Hybrid Assistive Limb)" is in the limelight. HAL is a robot suit of an exoskeleton type supporting a person who wears it, enhancing his or her movements with motor power.

This is how HAL works. When a person attempts to move, the brain sends nerve signals to the relevant muscles via motoneuron. As the movement takes place, very weak nerve signals leak out to the surface of the skin. They are called biopotential signals. A sensor gauges changes in such biosignals, thus identifying which signal commands which muscle movement. If signal changes are detected at a very fast speed and fed to the robot to manipulate its movements in sync with human muscles, then it is the birth of a robot moving just as desired by the person wearing it without manual control. HAL is based on that concept.

Two types of HAL have been developed. One is a full-body model weighing 23 kg and the other is a lower-body model weighing 15 kg. They operate 2 hours 40 minutes on a fully charged 100V battery. The person wearing HAL does not feel any of its weight because the robot supports both the wearer and itself after he or she climbs into it.

So far only the lower-body model has been put into practical use. "From now on, I would like to work on upper- and full-body models for practical use," Sankai said. HAL is already in practical use in the area of assisting elderly and physically handicapped people in moving their limbs. In 2008, CYBERDYNE began to produce HAL on a commercial basis for the first time in the world, starting with a welfare-purpose, lower-limb unit to assist walking. The HAL unit has been introduced by some local governments and hospitals in Japan *(Photo 2)*.

PHOTO 2 *Photo: Yoshiyuki Sankai, professor, University of Tsukuba & CEO, CYBERDYNE Inc.*

HAL is in practical use at welfare and nursing care facilities.

Japan is one of the world's most advanced countries in terms of the aging of society. People aged 65 or older in proportion to the total population are expected to increase from 20% in 2005 to more than 40% in 2055. Deterioration in physical action suffered by aged people tends to limit their functional indepen-

dence, trapping them in a vicious circle of further deterioration in both bodily action and functional self-reliance. Much has been expected of HAL, which helps seniors regain functional independence with technology, as a savior in the age of a graying society.

Sankai expressed his apprehension about the future of Japan's aging society by saying, "It is easily predictable that the cost of social welfare, such as rehabilitation, will swell and, on top of that, there will definitely be a shortage of care workers." He is improving HAL in hope of supplying a model for the world.

However, HAL's use in society faces a number of problems, including completion of necessary legal and social systems. Since it is an uncharted territory, Sankai said, "Japan needs to take the initiative in making rules for this area." Citing cars as an example, he said Japan in the past had to import everything – manufacturing technology, driving techniques and even an insurance system. "Unless Japan can build things from scratch like this, it will not be able to give birth to a new industry."

When it comes to HAL, the robot system will need global standardization in a broad spectrum of areas including a training program for users. HAL's promotion has started in Japan ahead of forthcoming full-scale promotion abroad. Besides an office set up in the Netherlands in 2007, CYBERDYNE is considering establishing a locally incorporated company somewhere in Northern Europe. Research has been under way in the United States. Efforts have thus been made to gain footholds in various countries for the spread of HAL by clearing hurdles in respective medical, welfare and other systems.

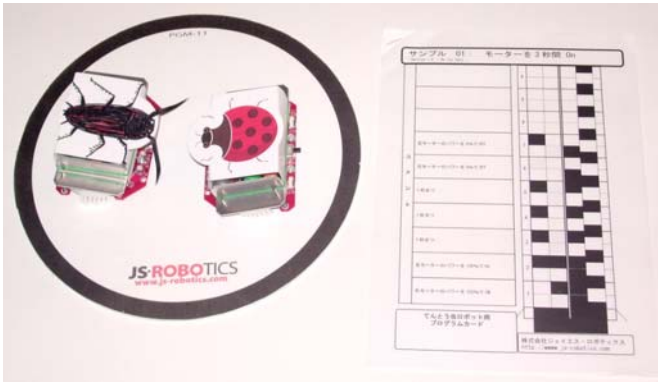
Start-ups Spring from Public Research Bodies

CYBERDYNE is not the only robotics-related venture firm in Tsukuba. General Robotix Inc. is a start-up set up to put in practical use and sell humanoid robot control software developed by NIAIST. General Robotix and the national institute have jointly developed "Taizo," a humanoid robot designed to work together with a licensed gymnastic instructor in performing rehabilitative exercise as part of preventive care. Standing 70 cm and fitted with 26 joints, Taizo also has a built-in voice recognition system for simple conversation. The robot is expected to display such effects as relaxing people with its conversational capabilities before they start rehabilitative exercise.

Applied Vision Systems Corp. is also a start-up established in 2004 to commercialize the outcome of research by NIAIST. The company is working on the application to products of the institute's three-dimensional vision technology (something akin to human eyes) essential for the next generation of robots.

Some start-ups do research on their own proprietary technologies without relying on technology transfers from public research institutes and universities. JS-Robotics Co., for example, has developed a miniaturized robot in the shape of a ladybug for sensor education *(Photo 3)*. Children can assemble the robot by putting together components, including a sensor-mounted electronic substrate and a vibration motor used in mobile phones for the silent-mode alarm. It is an educational product designed to teach children how a sensor works as an important element of robotics. The ladybug robot also represents the company's efforts to get children interested in robotics.

PHOTO 3



JS-Robotics' Ladybug Robot for teaching children sensor mechanism

What Is Needed for Takeoff of Next-Generation Robot Industry?

Currently, Japan's robot market is worth some 700 billion yen a year. Most robots are industrial robots of arm-manipulator types used in factories' manufacturing processes. The market for next-generation robots, which coexist with people in areas such as medicine, welfare and service, is estimated at 7 billion yen a year and is still at a fledgling, takeoff stage. For the next-generation robot market to get into full swing, round after round of demonstration experiments are indispensable to ensure safety, in addition to persistent technology development efforts.

In November, Tsukuba City held "Tsukuba Challenge," an outdoor contest in which self-contained robots compete for safe and steady walking. A promenade in Tsukuba, where the contest was held, is considered to provide a much desired opportunity for the verification of robots having to operate in the real environment. Reckoning that it is important to hold such events in public roads, parks and commercial facilities for the promotion of robots, Tsukuba City is set to place these undertakings on the official agenda. The city decided at a robot promotion meeting held in 2008 to construct "Robot Town Tsukuba," a community where people and robots can coexist. As targets to be achieved by 2015 in this connection, the city will seek to carry out 100 robot demonstration experiments, invite five new robot-related companies and research institutions to be set up in Tsukuba, incubate and start up 10 robot-related companies, and generate 500 new jobs. **JS**

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