Title	Towards the realization of a society in which robots are there for you : Real-Haptics and power electronics could be the key
Sub Title	
Author	池田, 亜希子(Ikeda, Akiko)
Publisher	Faculty of Science and Technology, Keio University
Publication year	2018
Jtitle	New Kyurizukai No.28 (2018. 10) ,p.2- 3
JaLC DOI	
Abstract	
Notes	The Research
Genre	Article
URL	https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=KO50001003-00000028-0002

In this issue, we introduce Assistant Professor Takahiro Nozaki of the Department of System Design Engineering who has set his sights on a society in which people and robots can live side by side.

Towards the realization of a society in which robots are there for you

Real-Haptics and power electronics could be the key

"Robot development" is gathering much attention as a solution to the shortage of labor resulting from a declining birthrate and an aging population. However, for robots and people to live together, there are many technical issues that need to be resolved. Assistant Professor Nozaki is tackling these issues through the Real-Haptics technology he inherited from his former teacher, Professor Kouhei Ohnishi, and technology he himself is developing in the field of power electronics.

Long-awaited arrival of a dexterous robot

Doraemon is a robotic cat who aids a boy with various gadgets from the future. Many people probably watched the animation as a child. Doraemon's birthday is September 3, 2112. Will such a robot be created in less than 100 years from now?

If you visit Assistant Professor Nozaki's web page on the Keio University Faculty of Science and Technology's Department of System Design Engineering website, a robot will appear at the top of the page (figure 1). The robot lifts up a plastic cup with one hand and pours water into it from a plastic bottle held in the other hand, following the actions of the operator in the operations system. I am astonished on seeing this, thinking "I've never seen anything like this!" Nozaki, who developed this robot, explains the reason why we are so amazed by this creation is because it is so dexterous. It doesn't crush the soft plastic cup, and even as the weight gradually increases when the water is poured, it doesn't drop it. Robots capable of such feats didn't exist until now.

Robots up to now crushed blueberries when they tried to pick one up. Nozaki describes this as being "clumsy," but it happens because without being able to sense that it has touched the blueberry, the robot can't adjust the amount of force it needs to apply. Although not robots, the reason you will be seriously injured if you come into contact with an escalator or train is because the escalator or train cannot sense that it has touched you.

The difficulty of acquiring a sense of touch

Robots that do the cleaning or guide people around facilities exist, but there are no robots that can perform caregiving duties. According to Nozaki, it is dangerous to use robots that can't sense that it has touched something, and therefore robots that touch humans have yet to be introduced into our daily lives. So, how can a robot be equipped with a sense of touch?

First, consider the characteristics of tactile sensation. Touch is one of the 5 senses humans use to sense the environment around them. The other 4 are vision, hearing, smell, and taste. While these 4 are all passive, touch is an active sense that is capable of moving objects and changing the world around us. Therefore, if there are expectations on robots to take on the duties that have been carried out by humans up to now, such as supplementing the shortage of labor due to a declining birthrate and an aging population, they must acquire a sense of touch and be capable of adjusting the amount of force to apply.

However, it is not easy to create actions that adjust applied force with touch. This is because actions have both a hard and soft side. The hard side of touch is the property of always wanting to go to the set location whatever happens, while the soft side is the property that makes adjustments when something is touched and a force is felt. For existing robots that do not directly touch human beings such as industrial robots, actions must be accurate, and emphasis has always been placed on the hard side. However, to create actions that adjust applied force with touch, both properties must be combined. Yet, from the beginning, these two properties conflict, making

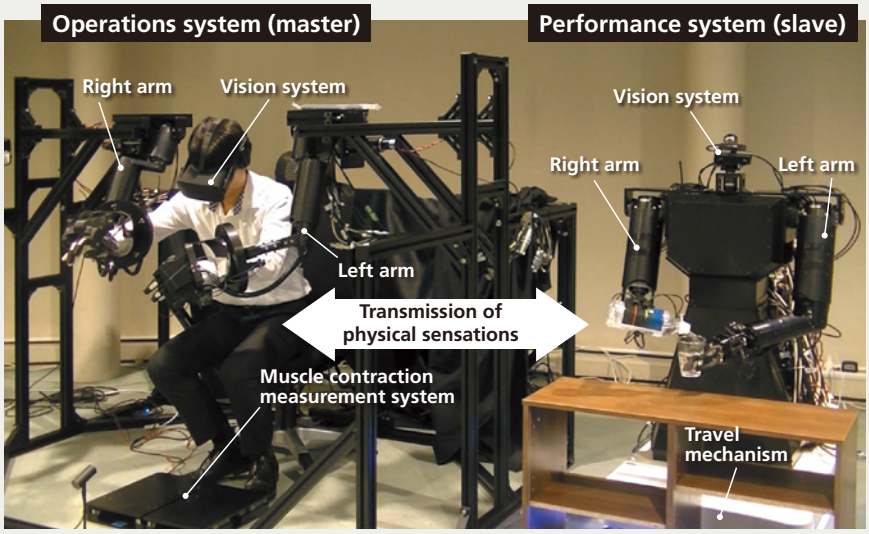

Fig.1 Robot with a sense of touch

Actions made on the operations system (master) are transmitted to the performance system (slave) to pour water into a cup. Tactile sensations on the performance system are transmitted to the human operator in the operations system allowing for the amount of applied force to hold a cup and to lift a plastic bottle to be adjusted.

the existence of the two together technologically difficult.

Nozaki's former teacher, Professor Kouhei Ohnishi, made it possible to combine these two properties through the development of Real-Haptics technology. By measuring the amount of motion required of the motor to move the robot, and collecting data on the additional force required to move the motor when it touches something, it can sense how hard the object it came into contact with is. This groundbreaking technology also led to the creation of the robot introduced on the web page at the beginning of this article.

Studying power electronics to develop better robots

It is not easy to move robots in the way you want. Even to bend the arm, the motor at the joint must gradually accelerate, reach a constant speed, and then decelerate and stop, and this process of accelerating and decelerating must be performed smoothly. Robots will only begin to move when each of these individual actions work in harmony.

Ultimately, the motors that move the robots are powered by electricity. Therefore, Nozaki began to think that it is important to know how to use electricity to develop better robots. In 2014, he went to study power electronics under Professor Atsuo Kawamura at Yokohama National University for a year. Since returning to Keio University, he has been developing power electronics technology that he believes will become useful in the future.

The field of power electronics, which looks at electricity supply sources and the conversion of electricity with the aim of efficiently transmitting electrical power to users, has been studied for a long time.

Once electrical power became available, it was used to run motors, and then motor drives were created. Next, accurate motor rotations and the running of several motors simultaneously were pursued, leading to the birth of fields such as control engineering and robotics. In this way, new academic fields and technologies came into existence one after another in response to the needs of society. According to Nozaki, at the forefront of this is Real-Haptics technology (figure 2).

For a single robot to function, a wide range of academic fields including power electronics, thermal engineering, motor drive, control engineering, motion control, robotics, mechanical engineering, human factors, and signal processing must come together. The complexity and instability of society has increased considerably, making it difficult to deal with all of the problems that are seen today through traditional academic fields alone. This can be resolved through a systematic design approach, which can be learned at the Department of System Design Engineering.

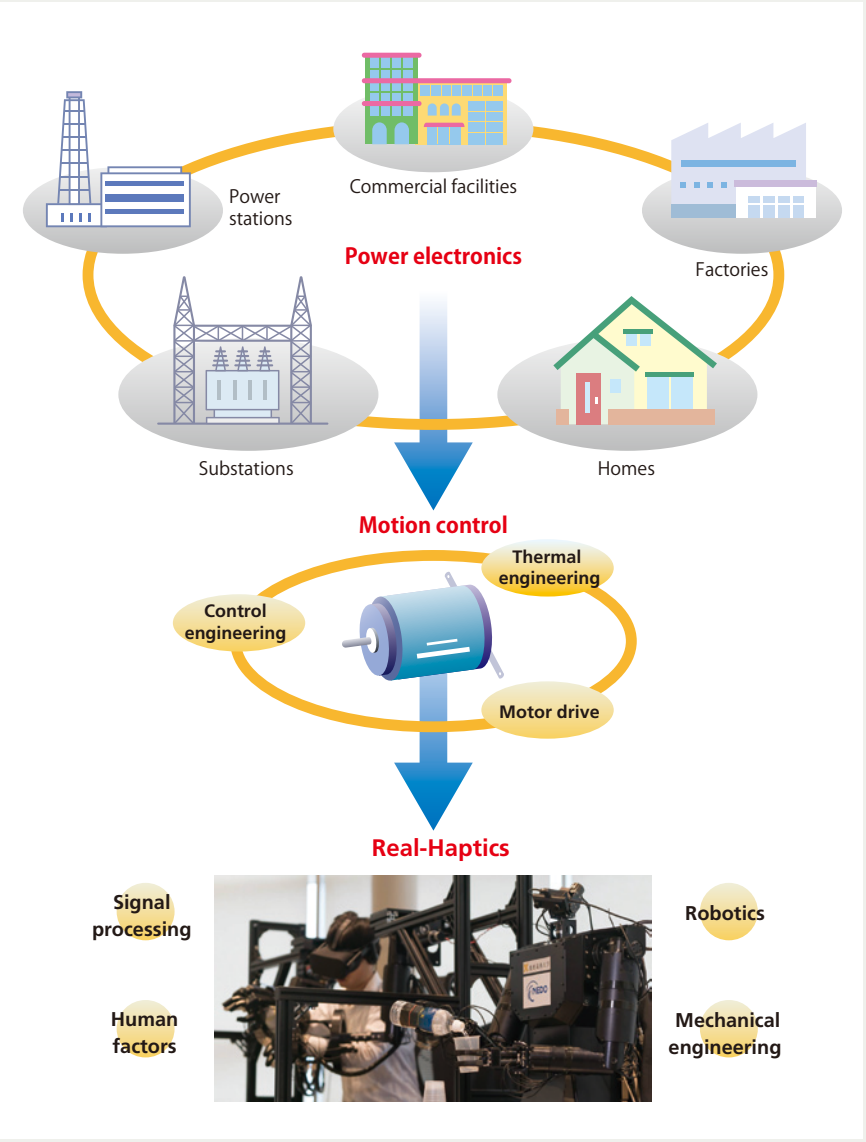

Fig.2: Power electronics and robots

New academic fields and technologies were created one after another in response to the needs of society. Achievements in these have been integrated to develop robots.

A future taking full advantage of touch and motion

Nozaki wants to continue to work hard in his research revolving around the two fields of "Real-Haptics," which he inherited from his teacher, and "power electronics," which he is advancing as a source of new strength in robotics. At the same time, however, he is working on product development with many industries to commercialize Real-Haptic technology. Currently, he is working with an airline to develop a system that enables people to experience fishing far away from the actual location without having to go there in person, while with a manufacturer of fruit sorting machinery, he is developing a fruit and vegetable sorting machine that will remove spoiled fruits without crushing them.

Just like making video and audio recordings to save and transmit what we see and hear, in the future, with the spread of Real-Haptics technology, it may become possible to save and transmit various movements and tactile sensations. What will the future be like then? Nozaki says that just like you wouldn't prepare a boat and bring in actors and the director to watch the movie "Titanic," you won't have to wake up in the morning and make an omelet by yourself anymore. You will simply download the motion data to make an omelet from the internet and have a robot do it for you.

It looks like this technology will bring us a future beyond our imagination.

(Interview and text writer : Akiko Ikeda)