Press Release

Keio University

NEDO 国立研究開発法人 新エネルギー・産業技術総合開発機構

October 23, 2017

Keio University
New Energy and Industrial Technology Development Organization (NEDO)

Successful Development of a Double Arm Robot Equipped with the World's First High Precision Haptic Technology to Transmit Physical Sensations

The New Energy and Industrial Technology Development Organization (NEDO) and Keio University (Assistant Professor Takahiro Nozaki and Professor Toshiyuki Murakami at the Faculty of Science and Technology Department of System Design Engineering and the Haptics Research Center [Keio Advanced Research Centers]) have successfully developed a double arm robot (general purpose arm) that transmits physical sensations.

This robot is capable of transmitting the sense of sight, hearing, and moving, and furthermore, it is equipped with the world's first high precision haptic technology which allows the robot to recreate the sense of touch, as if you were directly touching the object. This allows an operator to control the robot with a high sense of presence, even from far away.

Through this robot, the presence and actions of individuals are freed from spatial and temporal restrictions. It is hoped that the technology will replace humans in fields where human labor, time, and effort are required, such as in industry, the household, welfare and care, medical care, and agriculture, and facilitate the automation of tasks, reduce labor, and encourage cooperation between humans and robots.

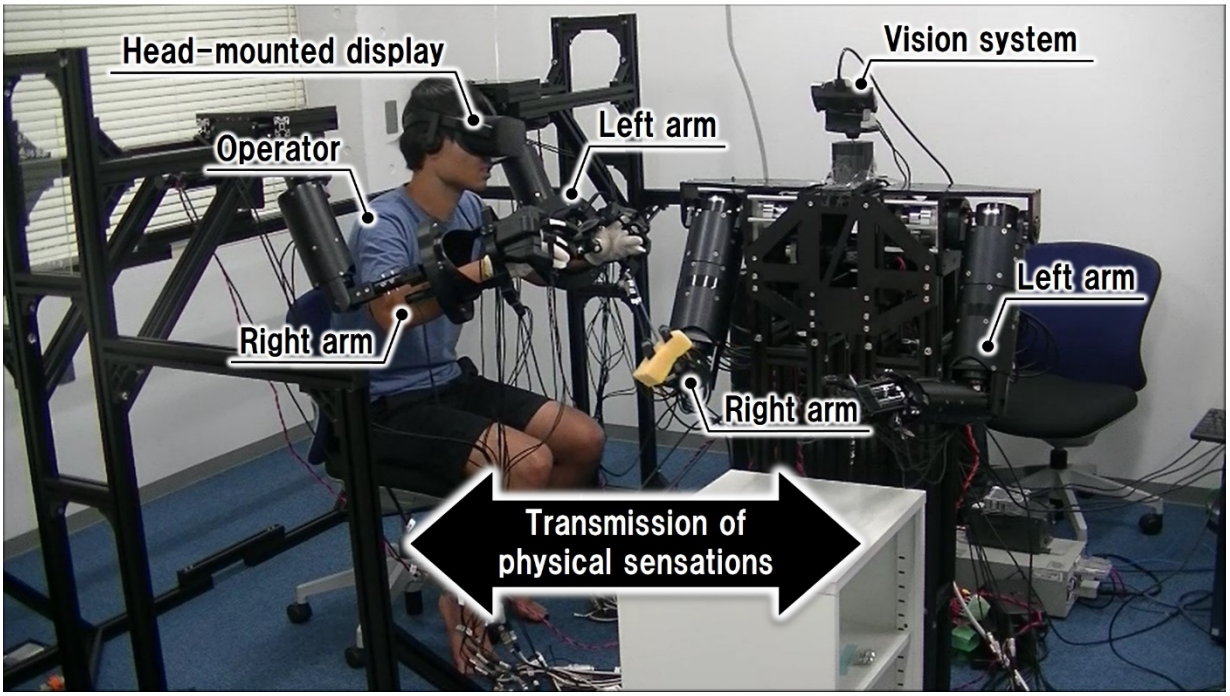

Figure 1: Double arm robot (general purpose arm)

1. Summary

Since NEDO started receiving funding through the "New Robot Strategy," which was formulated by the government in 2015, it has been promoting the development of core technology for next-generation AI and robots. This project goes beyond the scopes envisioned for technologies related to AI and robots by aiming to exceed human abilities as an innovative, underlying technology, and to create new demand in fields in which the introduction of AI and robots has never been thought of.

Recently, NEDO and Assistant Professor Nozaki and other researchers (*1) at Keio University's Faculty of Science and Technology Department of System Design Engineering successfully developed a double arm robot (general purpose arm) that can transmit physical sensations. This robot is capable of relaying the sense of sight, hearing, touching, and moving, allowing an operator to control the robot with a high sense of presence, even from far away. In particular, it is the world's first technology by which it is possible to recreate tactile sensations, enabling the operator to feel as if they were actually touching the object itself.

Through this robot, the presence and actions of individuals are freed from spatial and temporal restrictions, and it has become possible to produce environmentally adaptable, precise actions with flexibility and strength similar to that of humans. It is hoped that the technology will replace humans in fields where human labor, time, and effort are required, such as in industry, the household, welfare and care, medical care, and agriculture, and facilitate the automation of tasks, reduce labor, and encourage cooperation between humans and robots.

This robot was on display at the CEATEC JAPAN 2017 (*2) exhibition, which was held at Makuhari Messe from October 3 to 6, 2017.

2. Results

There are expectations that robot-assisted tasks will help support an ageing society with declining birthrates. Through haptic sensations, humans can adjust the amount of applied force, allowing them to flexibly perform a variety of tasks. However, in the past, robots were unable to make use of this sensation after it touched an object. They tended to break soft objects and objects of different shapes.

In this research, researchers were able to develop a double arm robot which makes use of the world's first high precision haptic technology (technology by which it is possible to recreate tactile sensations, enabling the operator to feel as if they were actually touching the object itself), allowing it to make masterful motions similar to those of humans. The following technologies are used to transmit the sense of sight, hearing, touching, and moving.

- Equipped with the world's first high precision haptic technology (Real-Haptics [*3]), the robot can relay tactile sensations to the operator.
- The vision system, which is made up of a head-mounted display and stereo camera, transmits sight and hearing.
- Movement is controlled by the muscle contraction measurement system, which transmits the state of the operators legs to the robot.

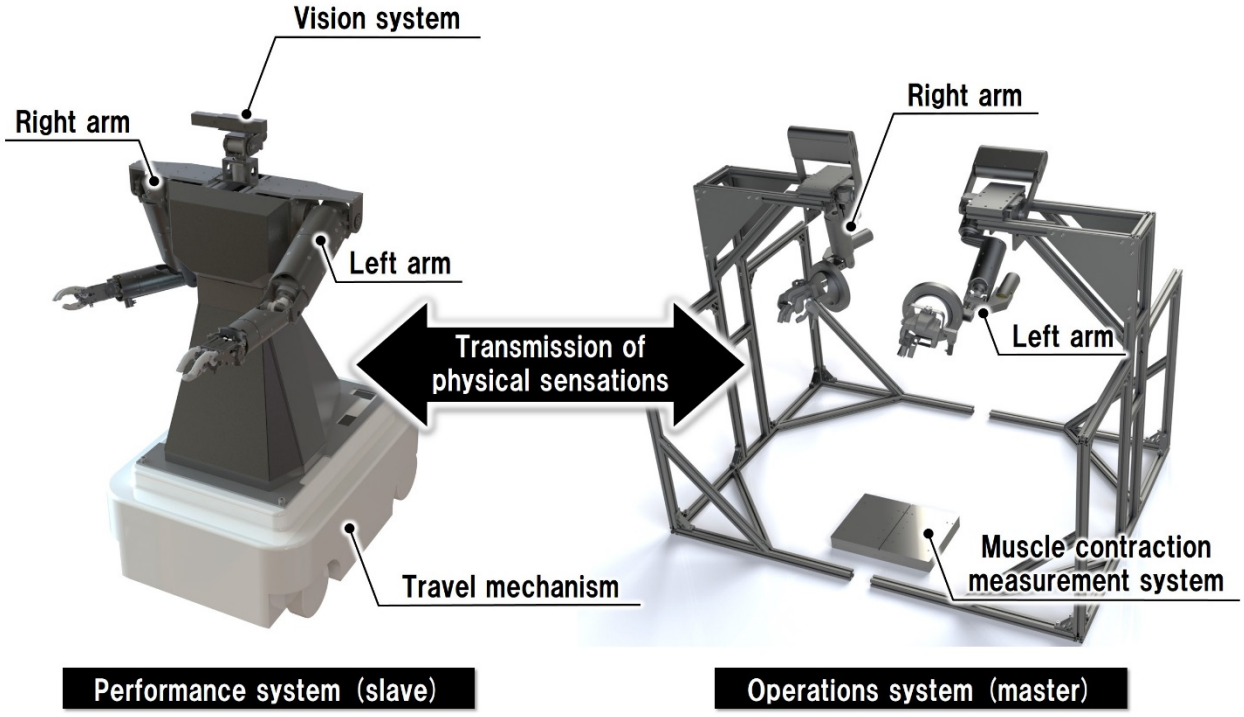

Figure 2: Configuration of system

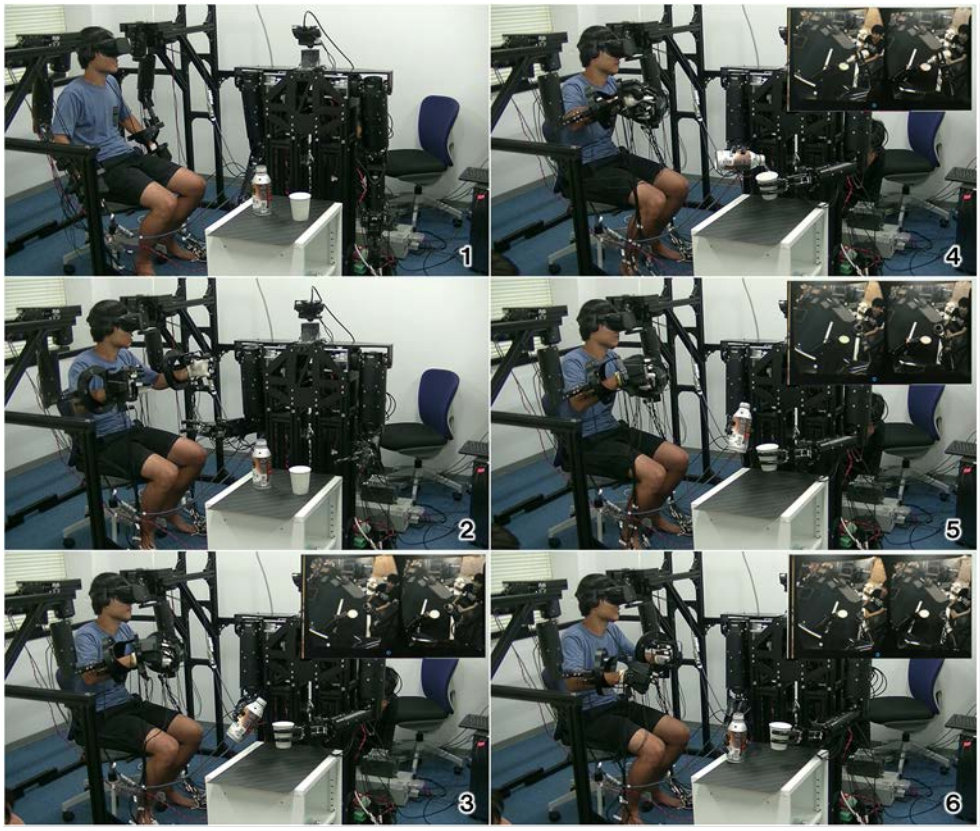

Figure 3: Operating the arms

Figures 1 and 2 show the configuration of the robot. This robot uses a master/slave configuration, where the master system operates the robot and the slave system performs the tasks. Figure 3

shows the robot being operated. When the operator moves the robot through the master system, the same movements are reproduced by the slave system. Also, when the slave system touches something, that sensation is transmitted back to the operator through the master, allowing the operator to feel the object as if they were actually touching the object. Furthermore, the robot has a vision system which follows the motion of the operator's head and changes the field of vision accordingly. This allows the operator to have a common visual field as the slave system, enabling them to acquire visual information of the site as if they were actually there. The slave system also has a travel mechanism. It travels in accordance with the movements picked up by the muscle contraction measurement system on the master system. In addition, it is capable of measuring the amounts of force applied by humans, which had been difficult to do up to now, and controlling the amount of applied force through the use of the measured forces while reproducing the motions of humans.

This robot allows tasks to be carried out at distant locations without the operator having to relocate. For this reason, it is hoped to replace humans in fields where human labor, time, and effort are required, such as in industry, the household, welfare and care, medical care, and agriculture, and facilitate the automation of tasks, reduce labor, and encourage cooperation between humans and robots. Specifically, use in the following areas are anticipated:

- Performing tasks safely but effectively in extreme or dangerous environments which humans cannot directly enter, such as radioactive environments, high altitudes, and deep sea, from a remote location.
- In production lines that manufacture a wide variety of products in small quantities and those that handle fragile products, automation is difficult and tasks still rely on manual labor. This robot will allow tasks that require skill and delicacy to be automated, greatly increasing productivity.
- In the entertainment industry, musicians will be able to play instruments remotely. Additionally, it will enable realistic pseudo-experience of travelling. In nursing care and welfare, with this robot, it will no longer be a dream for the elderly with difficulties walking to go out and enjoy the cherry blossoms or go shopping.

Figure 4: Various applications of the robot

Part of this research (muscle contraction measurement system) is funded by the Japan Society for the Promotion of Science (JSPS) Grants-in-Aid for Scientific Research Program (KAKENHI), Grant-in-Aid for Young Scientists (A) No. 16H06079.

Glossary

*1 Research Team Members

Keio University Faculty of Science and Technology Department of System Design Engineering Toshiyuki Murakami (Professor) and Takahiro Nozaki (Assistant Professor)

Haptics Research Center (Keio University Advanced Research Centers) Dean: Kouhei Ohnishi (Professor), Vice-Dean: Akira Nagashima (Project Professor), others

*2 CEATEC JAPAN 2017

CEATEC JAPAN is an exhibition that looks to a future society suffused with information, ushering in a new industrial revolution driven by data. This international event brings together the people, the ideas and the technologies that will realize this future. Visitors can benefit from new business opportunities and exchange information on the latest trends and developments. CEATEC JAPAN offers innovative new solutions to the issues facing society, contributing to progress at the community level and to improved lifestyles at the individual level. The exhibition was held at Makuhari Messe from October 3 to 6, 2017.

http://www.ceatec.com/en/

*3 Real-Haptics

In the past, haptic technology relied on phenomena such as vibrations to transmit pseudo-sensations of touch. On the other hand, Real-Haptics is a technology that communicates information such as the actual firmness and softness, as well as deformations and curvatures, of an object. Through this technology, it becomes possible to transmit tactile sensations back to the operator as if they were actually touching the object. This technology received an honorable mention at CEATEC JAPAN 2016, and the technology has also been patented.

3. Inquiries

Inquiries about the research

NEDO Robot and Artificial Intelligence Technology Department (Contact persons: Teraoka, Ishikura)

Tel: +81-44-520-5241

Keio University Faculty of Science and Technology Department of System Design Engineering Assistant Professor Takahiro Nozaki

Tel: +81-45-566-1823　E-mail: nozaki@sd.keio.ac.jp

General inquiries about NEDO

NEDO Public Relations Department (Contact persons: Kotsusa, Sakamoto, Fujimoto)

Tel: +81-44-520-5151　E-mail: nedo_press@ml.nedo.go.jp

General inquiries about Keio University

Keio University Office of Communications and Public Relations (Contact persons: Murakami, Yamazaki, Takeuchi)

Tel: +81-3-5427-1541　Email: m-koho@adst.keio.ac.jp