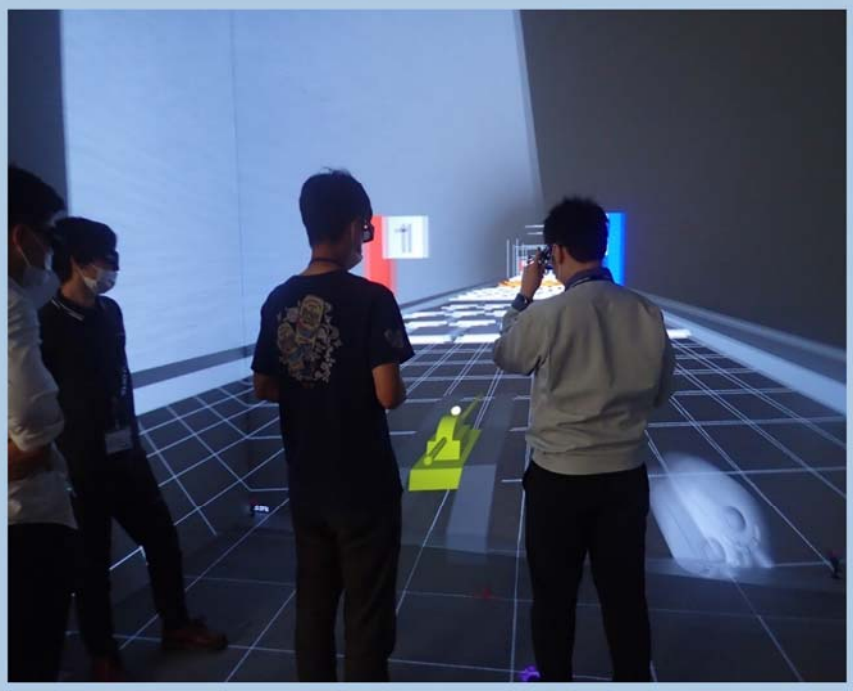
Topics Fukushima
November 11, 2020 No.102



Students training for robot simulator using VR[*1)] system.
(They are looking at three-dimensional images by wearing special goggles.)

"Remote-control technology" promotes the decommissioning of the Fukushima Daiichi Nuclear Power Station

Students who will lead the next generation learned at the summer internship.

Japan Atomic Energy Agency (JAEA) holds summer internships every year to promote the understanding of nuclear energy and to develop human resources in nuclear energy field.

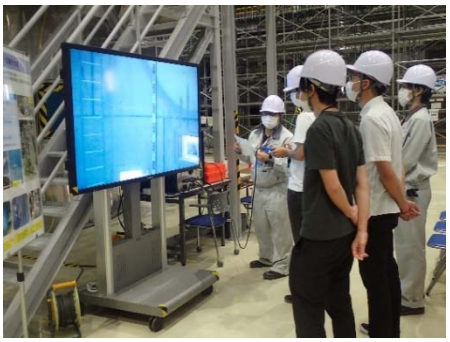
As one of the internships, the Naraha Center for Remote Control Technology Development (hereafter referred to "NARREC"), Sector of Fukushima Research and Development, held a one-week training course from August 31, 2020 on the theme "Decommissioning of the Fukushima Daiichi Nuclear Power Station (hereafter referred to "1F") and Remote-control Technology for Nuclear Disaster Response". Three students of Keio University and Tokyo City University participated in this internship.

Followings are the report on the contents of the training which the students experienced.

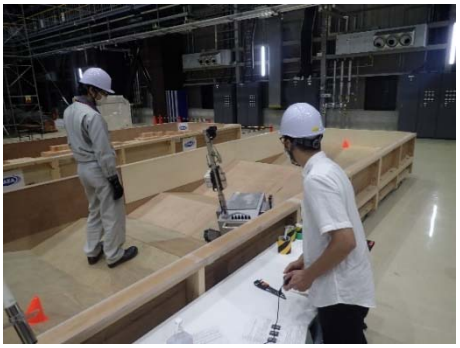
◈ Internship began with lectures on robots, and operation of robots

At the beginning, Dr. Ishihara, Director of NARREC, gave a lecture explaining the outline, roles and the past activities of the NARREC related to the 1F decommissioning. Next, before the training, the JAEA staff gave lectures on the outline of the 1F accident, nuclear disaster response by robots and obtained lessons, and radiation management (right photograph). The students earnestly listened to the lectures, and actively asked questions. So, the students seemed to try to be actively learning.

Next, at the "Test Building" that is a large test facility, the students practiced the operation of underwater robots, crawler-type (structure using belts as wheels) robots and drones. The students experienced the difficulties in robot operation under severe conditions such as underwater and with obstacles/steps, which are assumed at the real site in the reactor buildings.



First training was the operation for underwater robots. They observed robots through the window of the water tank, and practiced letting robot go through obstacles located in the water tank. At the beginning, they were unable to properly operate due to the effect of underwater resistance. But as they repeated the practice, they gradually became able to let the robots move to the proper destination. Next, the students challenged to operate a robot based only on the images that were taken by the camera loaded on the robot. Since the field of view of the camera was extremely narrow compared with visual observation, they sometimes lost the direction and distance of the robots. So, the students seemed to struggle to operate robots (left photograph).

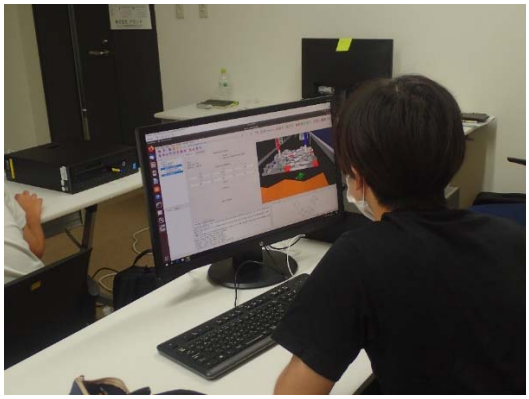


Since a crawler-type robot moves on rough surface, an operator has to move it so as not to be fell down and consider its safe route. Therefore, the students seemed to feel the difficulty in operating it (right photograph).

◈ Practice of robot simulator

From the next day, “Training for robot simulator” based on the software Choreonoid[*2)] began for 2.5 days.

First, in order to learn the basic operation, the students made simulation data, in which the “Tank” model” that is a sample model was operated with game pad, while listening to the lecture.



Next, the students challenged the application subject. In this subject, the students tried to let the robots move based on the robot model made by themselves along the course which simulates a disaster site. In order to solve the problems in the subject, the students tried to reform the robots. In the course simulating a disaster site, narrow parts, obstacles, and steps were placed in advance. Therefore, the robots were sometimes unable to get over the steps, and they fell down. So, the robots could not complete the race by the “Tank” model made first. Nevertheless, by referencing crawler-type robots which they had learned, the students tried to reform the model, lower the center of gravity to stabilize the robot, and seek the safe driving route. Through these efforts, the students improved their operation technique with try and error (upper photograph).

As a final application subject, a competition was held, in which the students operated the model made this time, while looking at the VR (photograph in the first page). In the competition, the students demonstrated their originality and ingenuity that they themselves had devised, so all students excellently succeeded in letting the robots move completely through the course. As a next competition, the students challenged to let the robots carry objects through a narrow bridge. In spite of the limited time, the students seemed to struggle, while making efforts with their own originality and ingenuity. For example, a student made the own original improvements for the model according to the course.

◈ After the internship

On the final day, each student gave a presentation on the summary of the results obtained in the one-week internship. The students presented how they solved the problems and their impression. Finally, Mr. Kashima, Deputy Director of NARREC, gave

a concluding remark, “When I heard that you are interested in the 1F decommissioning, I was glad to feel that your ambition is so high. I think that through this internship, you were able to experience the remote-control technology by which the decommissioning work at the site can be smoothly promoted. I sincerely expect your future activity in the field of nuclear energy.”

After the internship, responding to the interview, three students expressed their impression and future aspiration.

—Mr. Shuma Tanaka, Keio University

When I saw JAEA’s activities for 1F decommissioning on TV, I could not understand how they are working on the decommissioning. But through the internship, I could understand it well. In future, I want to work on the development of robots related to nuclear energy.

—Mr. Kazuma Suzuki, Tokyo City University

It was very exciting for me to be able to experience various remote-control technologies related to the 1F decommissioning. I was able to learn both real apparatuses and simulation. I was happy to be able to learn the subjects that cannot be done in the research at the University.

I want to make use of the simulator on Choreonoid for future research.

—Mr. Motomi Mashiko, Tokyo City University

I was able to experience various remote-control technologies through the internship. In particular, the training in the “Test Building” was impressive. I tried to operate a robot while watching the camera image, but it was so difficult that I could not let the robot move as I wished.

I felt that the road to the decommissioning is still steep. Nevertheless, I felt painful that it is important to steadily proceed step by step.

Considering the results of the internships such as the comments by students, the NARREC will enhance the contents of the program in the internship. Through these activities, JAEA will actively continue to the development of human resources. Also, JAEA will contribute to the promotion of the development for remote-control technology, aiming to the smooth implementation of the 1F decommissioning.

【Terminology】

***1) Virtual Reality (VR)**

VR is a technology that creates not real environment but environment that is sensually equivalent to the real one. The NARREC has a technology where a person can experience the sense as if he/she were in the real site. Using this technology, it will become possible to train workers and make work plans. Also, the technology is expected to reduce the radiation exposure of the workers in the 1F, and be useful for the efficient works.

***2) Choreonoid**

An open-source integrated software for robots, developed and published by the National Institute of Advanced Industrial Science and Technology. It is designed so that any functions can be added as plugin (function extension) on the general basic functions. It is also equipped with the functions of dynamics simulation and choreography as plugin. Since a plugin can be linked to the other plugins, the function can be further extended while using the existing functions. Therefore, it has a highly extensible structure as a whole framework.

(References)

Summer schools held in FY2020 at the Sector of Fukushima Research and Development are listed below.

○ Naraha Center for Remote Control Technology Development (NARREC)

·August 31~September 4, 2020: 3 students for “Remote-control technology”

○ Collaborative Laboratories for Advanced Decommissioning Science (CLADS)

·August 17~August 28, 2020: 2 students for “Environmental Dynamic Study”

·August 24~August 28, 2020: 2 students for “Environmental Dynamic Study”

·September 1~September 11, 2020: 3 students(note) for “Environmental Dynamic Study”

(note) One student participated from September 3 to September 10.

·August 17~August 28, 2020 : 2 students for “Radiolysis of water”

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