R&D Theme

Robot Hardware for Earthwork Innovation

Progress until FY2022

1. Outline of the project

This project aims to achieve "infrastructure construction adapted to diverse environments through collaborative AI robots." A system that can operate in dynamically changing environments, such as natural disaster sites, is necessary to achieve this goal. However, the conventional design philosophy of machine engineering has been limited to pre-determined environments (Figure 2, left). Therefore, we propose the design methodology called "open design" (Figure 2, right) to realize a robust robotic system. In this R&D theme, we have set sub-tasks such as innovative earthwork technologies, innovative robotic mobility technologies, robot platform development, technologies for dealing with river channel blockages, and construction technologies for lunar landing sites. The following section describes the main achievements of this research and development in 2022.
In addition, developed technologies can be applicable to the earth such as natural disasters and etc.

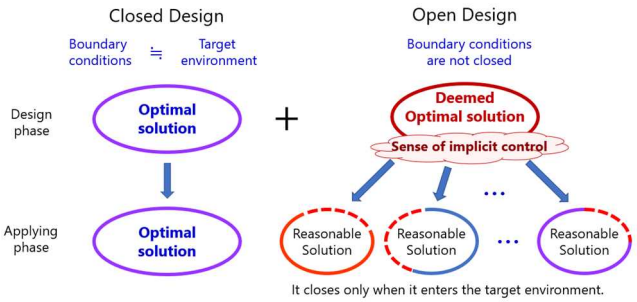

Fig.2 Closed design and open design.

2. Outcome so far

A drainage hose laying robot, which allows for remote installation of drainage hoses during disasters such as river channel blockages, was developed by a group from Osaka University. River channel blockage refers to the phenomenon where landslides caused by earthquakes or heavy rainfall occur, obstructing the flow of the river and forming a natural dam. As the water supply to the river continues, it is necessary to move the accumulated water from the upstream area to the downstream area to prevent debris flows resulting from the collapse of the dam. Currently, drainage pumps are used during the construction of waterways until completion, but their installation is manually carried out in unstable and hazardous environments. To address this problem, we have developed the "i-Centipot Hose," which allows for the remote installation of drainage hoses in unstable environments.

Fig.3 Drainage pump laying robot "i-CentiPot-Hose."

The robot primarily uses a tracked robot for transporting the drainage pump and hose. A feature of the robot is that multiple small robots are placed in between to support the hose to reduce the friction between it and the ground when dragging it. The robot was demonstrated at the international conference IROS 2022 exhibition booth, where concept validation was conducted. Furthermore, we have improved the robot platform for constructing lunar landing sites. In the low-gravity environment of the moon, the compaction efficiency using the weight of rollers, which is effective on Earth, is expected to decrease. Therefore, as shown in Figure 4, we have developed a mechanism that integrates compaction rollers directly beneath the small robot platform. The hardware allows the vehicle's weight to be utilized for compaction and enables control of the compaction force. With this innovation, we anticipate achieving effective compaction even in a low-gravity environment.

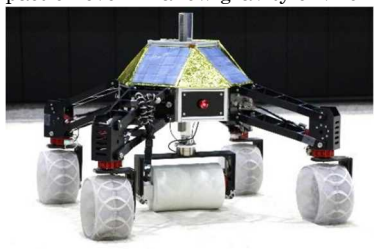

Fig.4 Lunar robot platform with a pressure roller.

Because of the space limitation, only a small part of this year's achievements can be mentioned here. In addition to the mentioned projects, we have also conducted development on various other fronts. These include the "Flexible Dual-Hull Tracks with Adjustable Shape," the "3-ton Electric Tool-Exchange Robot with Precise Arm Control," the "3-ton Mini Hydraulic Excavator Capable of Installing Drainage Pumps," and "Remote Installation Sensing Equipment for Hydrological Observation." These sub-themes demonstrate our commitment to advancing technology and addressing diverse challenges.

3. Future plans

The goal for the research project is to achieve earthwork tasks in dynamic environments using multiple small robots. To achieve this, we will develop several prototypes by 2023 and conduct performance evaluation tests. We believe that these prototype robots will adapt to rapidly changing conditions and enable the completion of earthwork tasks.