R&D Theme

R&D of Adaptable AI-enabled robots

Progress until FY2022

1. Outline of the project

In this research theme, we are developing robot hardware with actuators and mechanisms that can be soft, firm, or adjustable in flexibility, as well as sensing and control technologies adapted to such hardware, with the aim of freely adapting to humans and the environment.

We are developing an adaptable AI robot that can transform its shape and form according to a person's purpose, physique, degree of disability, and other factors, as well as technology to estimate a person's intentions and actions. A robotic Nimbus is a robot concept that can softly deform like a cloud and extend human motion and function based on human intention, like a Flying Nimbus vehicle.

2. Outcome so far

In order to develop robotic hardware that provides physical support to overcome physical disabilities and poor movement, it is difficult to build a single high-functionality robot that can adapt to all the individual characteristics of the person and the environment and purpose of use. Therefore, in this theme, we have developed an elemental technology for robot hardware called Nimbus Elements, which can provide support tailored to a person's condition (physique, disability, etc.), environment, and purpose, while freely transforming, attaching, and detaching like a cloud.

By freely combining Nimbus Elements to reconfigure their shapes and functions, and by providing support according to the purpose, robots with various shapes and forms can be realized. The cloud-like softness of the Nimbus Elements facilitates cooperative control among Nimbus Elements, and also facilitates the cooperative motion of multiple robots composed of Nimbus Elements.

In FY2022, the following Nimbus Elements were developed to realize movement primitives according to the support configuration (grasping, holding, moving, manipulating, etc.). Comfort Element (temperature and humidity control), Actuation Element (light assistance), Holding Element (holding a human), Grasping Element (grasping an object), Moving Element (moving human/object), Supporting Element (supporting a human or assisting in movement), and Manipulation Element (manipulating object),

The handling of flexible and irregularly shaped objects is more challenging than the handling of rigid and shaped objects. In addition, humans are not only soft, but also delicate, and supported stably, which cannot be achieved with conventional robot hardware. Therefore, it is necessary to develop new robot hardware with actuators and mechanisms that can be soft or firm, and whose flexibility can be adjusted.

In FY2022, the following technologies were developed as new robot hardware elements. Technology to achieve both gentle wrapping along the human body shape and trunk retention, technology to achieve both flexibility and heavy-weight transportation, technology to achieve both lightweight enough to be worn by a person and rigid enough to maintain the posture of the trunk, arms, and legs, technology for temperature-, humidity-, and friction-coefficients changeable skins that adjust to human comfort, a mechanism that can expand and contract freely according to a person's height and posture, etc.

In order to expand humans' capabilities, we have also developed object manipulation technology that senses human intention and allows the robot to feel its own physical expansion. In addition, we have developed a technology that enables a cloud-like robot that provides fluffy support to feel as if it were part of the body, and to perform supportive actions without a sense of discomfort (feeling that it is moving on its own).

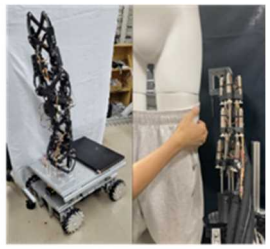

Comfort Element


Actuation Element


Holding Element


Moving Element


Supporting Element


Manipulation Element

3. Future plans

- Develop various Robotics Nimbus prototypes by integrating the developed Nimbus Elements appropriately.
- Extract support actions/tasks to realize the scenarios of care robot support formulated from the viewpoint of social implementation, and realize them by appropriately integrating the developed Robotics Nimbus prototypes.
- Verify the degree of accomplishment of the extracted support actions/tasks in the Living Lab.