Symbiotic Robot AI to Extend Healthy Life Expectancy

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1. Background

In this period of the declining birthrate and aging population, Japan has been promoting preventive health and health management that center around the three pillars of "Frailty prevention in care for the elderly," "Preventive health measures for working generations" and "Effective utilization of medical resources," with an aim to achieve the goal of creating a "society where people live a longer and healthy life" by 2025. There are also extensive researches being conducted in many other countries to improve people's mental and physical functions, nutritional status, social participation to increase their healthy life expectancies. However, while these researches can be effective in increasing the healthy life expectancy, they lack the perspectives of ordinary citizens, without sufficient considerations of how they can be supported in raising their awareness of their own health and increasing positive attitude toward their lives. It is yet unknown how we can create lifestyles and environments where people become more aware of their own health and more willing to take actions to improve their health. To help people's healthy life expectancies increase in a self-sustained manner, it is essential to unravel this question scientifically and create a technological foundation to support a society facing the declining birthrate and aging population.

Looking back our history, the human lifespan is deeply connected with scientific invention and discovery. The discovery of firearms and ironware transformed our means of life and environments, thereby improving our nutritional status, and the invention of microscope and technical advancement in drug manufacturing extended our longevity. Today, when technologies for calculation and telecommunication are highly advanced, robots and AIs, following CTs and MRIs, have been increasingly introduced in medical diagnosis and treatment. However, robots and AIs supporting operations and diagnosis are still considered as additional tools for medical professionals, and remains to contribute to microscopic intervention with cells and organs. It is desired to expand the plications of the next generation robots and AIs by proactively intervening with people or patients' will and incorporating them into macroscopic systems such as human behaviors and psychology.

2. Purpose

In this research, we aim to enhance health characteristics intrinsic in individuals by having a symbiotic robot AI learn group behaviors as well as attune and intervene in an imitative manner. Substantive experiments at nursing care, healthcare and disability care facilities have proven that symbiotic robot AIs create changes in group behaviors and perceptions through interactions. For example, patients with dementia living in nursing homes can experience improved sleep and less restless behaviors at night when they are allowed to walk around freely within their facilities accompanied by the robot. Another example is that patients can learn to feel when they need to excrete as the robot guide them to the toilet when it receives a toileting alert from a sensor attached to the patient. This research is designed to utilize a robot AI, sensor network, human interface and cloud system to attune and intervene in human groups and assist them in expanding their healthy life expectancies in a self-sustained manner by encouraging them to acquire health-enhancing behaviors and mindsets.

We focus on three aspects - "walking," "conversation" and "eating" - as areas of mutual interaction between the symbiotic robot AI and human groups, with emphasis on attunement and interventions such as full-body motion, somatic sense, sense of balance for walking and others; situation awareness, as well as hearing/visual perception and others for conversation; and mastication, in addition to senses of taste/smell/touch and others for eating. While mutual interaction between humans and robots are linked to robot therapies that have been becoming popular in recent years, our research differs from robot therapies in that it is designed to control the level of intervention so that robots promote humans' development of cognitive movement but finally make them not dependent on robots. In other words, the robots are intended to support humans but to be phased out of their lives in the future.

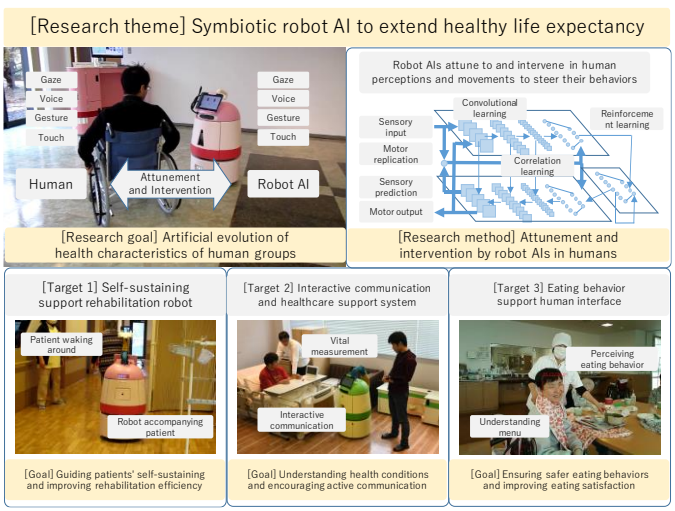


Figure 1. Overview

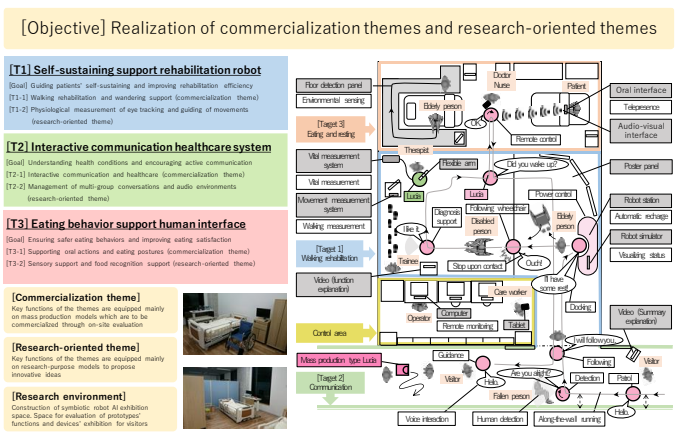


Figure 2. Development target

Research project website:
https://www.syblab.org/research/shelp_en.html

3. Development

This research intends to experimentally create an AI application system capable of attunement and intervention in human groups in various situations by setting research and development targets (T1, T2, T3) corresponding to the three areas of "walking," "conversation" and "eating." The developed system will be equipped on our symbiotic robots Lucia and Kurumi which form the technological foundation of our research, and will be evaluated for functionality at locations including nursing care and day service facilities, hospitals and home care settings. The research aspect will involve social welfare corporations and medical research centers for test and evaluation while the business aspect will include equipment and prototype manufacturers who will support commercializing of our research results. The final goal of our project is on-site application of the symbiotic robot AI application at partner organizations.

The research and development target T1 is designed to develop a self-sustaining support rehabilitation robot along with the subthemes of "walking rehabilitation and wandering support" and "physiological measurement of eye tracking and guiding of movements" to guide people's autonomous movements and improve rehabilitation efficiency. In the research and development target T2, we will develop an interactive communication healthcare system with the subthemes of "interactive communication and healthcare" as well as "management of multi-group conversations and audio environments" to achieve attuning actions by the symbiotic robot and cloud AI and encourage active communication. The research and development target T3 aims to develop an eating support interface around the subthemes of "supporting oral actions and eating postures" and "sensory support and food recognition support" to increase cognitive abilities related to eating and improve the level of eating satisfaction.

4. Road Map

The research will proceed according to a road map developed at the start of the project. Each research and development target sets a commercialization theme and a research-oriented theme, with commercialization intended to reach a commercialization evaluation phase within the research period and the research-oriented themes covering on-site research to prototype evaluation. With the purpose of promoting research and development, we will hold research and development conferences and open seminars on a regular basis to share individual themes of our research and development targets as well as results of student research projects. There will be a dedicated room within the laboratory where the symbiotic robot AI will be exhibited for the purposes of functionality tests prior to on-site testing, as well as another room for showcasing devices for visitors to have sensory experiences.

We utilize symbiotic robots Lucia and Kurumi, which have been created as a research-purpose model and dissemination models, respectively, as the technological foundations of our research. Lucia is equipped with key functions which allow for interaction, patrolling, remote control, vital movement measurement while working in tandem with sensorimotor interface for the mouth, hands/fingers and the soles of the feet. Kurumi's functionality focuses on patrolling and human detection, allowing for low-cost operation. We will combine these robots with the rapidly-evolving convolutional NN type machine learning system to realize a symbiotic robot AI application system imitatively attuning to human gaze, voice, gesture and senses to intervene with cognitive behaviors, exploring innovative principles for promoting the development of human health characteristics.

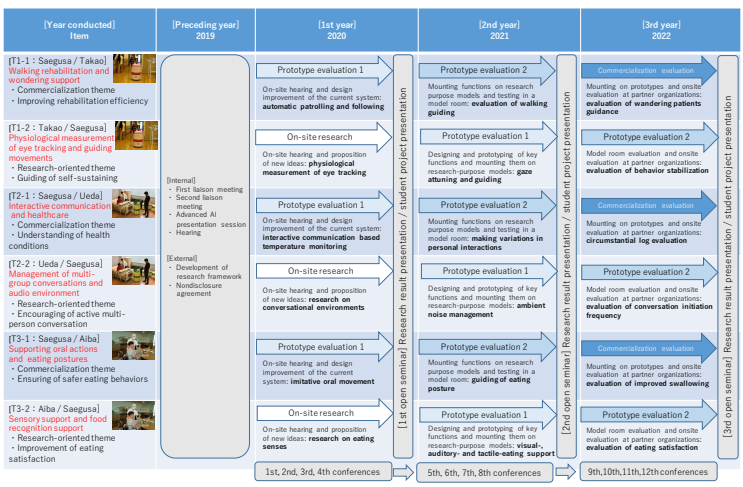


Figure 3. Road map

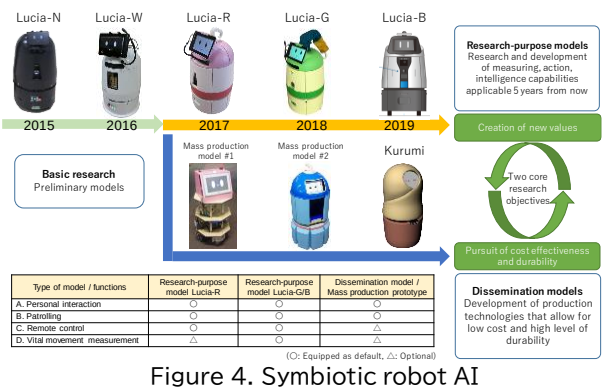


Figure 4. Symbiotic robot AI

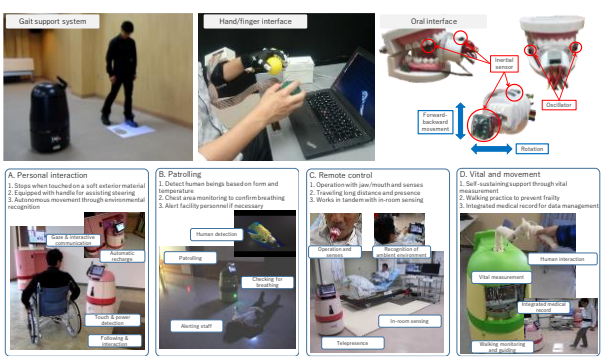


Figure 5. System interface