

Summary of On-going Projects

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1. Science of Awareness

How can robots become true friends to humans? This project explores the development of robotic systems that provide appropriate awareness-referred to as awareness AI-to enable effective coexistence between humans and robots. Awareness, in this context, can be understood as the ability to independently recognize changes in one's surroundings, oneself, or necessary matters. Humans tend to be less motivated by forced actions from others but are more likely to take proactive steps when they arrive at realizations on their own. A true friend does not coerce but inspires and empowers one to move forward. Similarly, can robots motivate humans in a positive way? Furthermore, can we create systems that not only encourage us but also utilize information and knowledge inaccessible to humans, thereby achieving greater effectiveness in fostering motivation?

In this project, we began by engineering an understanding of the mechanisms of awareness based on neuroscience and established approaches to induce awareness through robotic intervention. Using this foundation, we implemented robotic assistance to promote proactive behavioral changes in various contexts. Starting with universally positive transformations, such as alleviating pain or recovering from motor paralysis, we aim to extend these efforts toward fostering deeper, more personal changes. In the coming 5 years, we will apply it to robotics hospitals and smart cities.

2. Muscle Look Through



Standing support Robot by Awareness AI

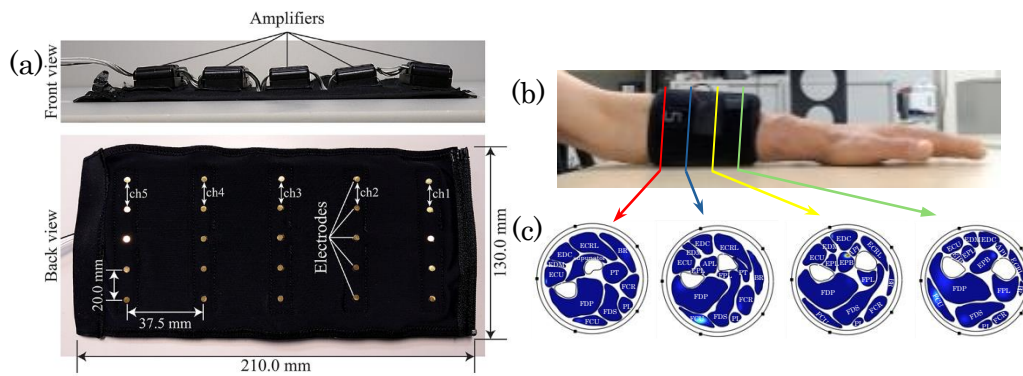


Concepts of Robotics Hospital and Smart Town with Awareness AI

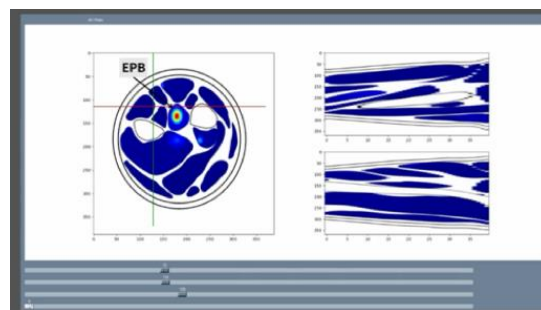
We have developed a muscle activity measurement sensor capable of estimating deep muscle activity. This innovative device addresses the unmet medical needs associated with functional neurological disorder (FND), a condition often classified as a subset of dystonia.

FND patients experience symptoms such as motion paralysis, tremors, and chronic pain in daily life, despite the underlying causes remaining unclear through conventional medical approaches. Utilizing our muscle activity sensor, we observed that abnormal activity in a specific forearm muscle frequently contributes to these symptoms in FND patients. Clinical trials demonstrated that targeted anesthetic injections significantly and immediately improved patients' conditions following treatment.

We aim to expand the application of this muscle insight system to other limb muscles, potentially broadening its impact on similar disorders.



Muscle activity sensor that can estimate the deep muscle activities.



4D data is created through the functional observation

Before treatment



After treatment



Motion paralysis disappeared after anesthetic injection

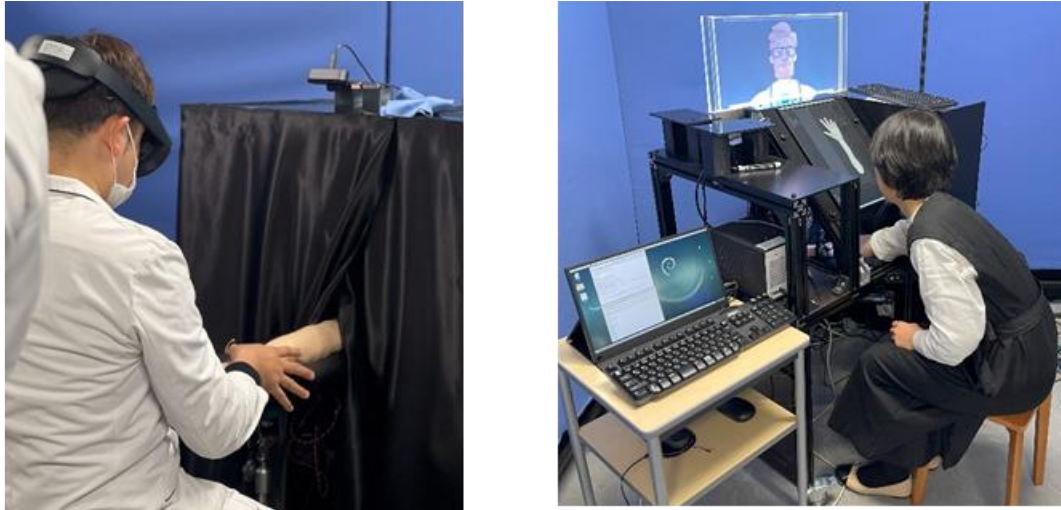
3. Remote Palpation System

Palpation is a traditional and essential approach for accurate medical diagnosis. In conventional remote palpation systems, the tactile condition of the patient is conveyed to doctors primarily through force feedback mechanisms. However, an analysis of the cognitive processes involved in palpation suggests that its true purpose is not merely to replicate the tactile details of the affected area. Instead, palpation serves as a trigger for doctors to synthesize information, combining tactile sensations with findings from other assessments, past experiences, memory, and the patient's reactions to touch, ultimately forming a clear understanding of the medical issue.

Building on this understanding, we developed a remote palpation system under the concept of "Palpation Reality Beyond Real." This system goes beyond simple tactile replication, offering doctors enhanced information that fosters awareness and aids in forming a comprehensive

understanding of the patient's medical condition, thereby supporting cognitive functions during medical examinations.

We have conducted the clinical trials between Singapore and Japan in February 2025, in collaboration with Singapore National University Hospital, to validate the system's effectiveness.



Overview of Remote Palpation System

4. Space Computing for Cognitive Function Enhancement

While the advancement of IT technologies—centered on the internet—has brought about increased convenience and globalization, it has also exacerbated wealth disparity and ideological polarization, leading to a “fragmented society” that threatens the very foundations of a safe and secure world. To address this issue, we propose that the key lies in the integration of neuroscience and AI robotics. Recent progress in brain science has made it increasingly possible to scientifically interpret even abstract concepts such as “well-being” and “trust” through brain activity. It is now believed that factors contributing to social division include excessive rationality in the prefrontal cortex and a lack of emotional regulation. Meanwhile, AI robotics is evolving beyond physical support functions, demonstrating potential as an intervention tool to help regulate the brain's neural states. Our previous work in developing a remote palpation system has shown that robots can play a role in building trust within human relationships.

Based on this foundation, the present study aims to develop and validate a Multi-Modal Sensory Computing (MMSC) system—a foundational technology designed to promote communication and enhance cognitive functions within the home environment by utilizing human-centered data. The

household setting is where individuals most naturally reveal their “authentic selves” and where changes in cognitive function often first become apparent. If we can establish technologies that effectively modulate the activity of deep brain networks—such as the insular cortex and hippocampus—in this context, we believe it will make a significant contribution toward overcoming societal fragmentation and achieving a safer, more secure society.

