FROM MEDICAL ROBOTS TO A MOUSE METAVERSE

Scientists in Japan are targeting physical and mental health in a series of projects as part of the country's AMBITIOUS MOONSHOT PROGRAMME.

Neurosurgeon, Yoshihiro Muragaki, is supported by the Japanese government's Moonshot Research and Development Program which has the goal of building a 'human–robot symbiotic society'. Technology being developed under this initiative includes robots that can support health monitoring and care at home, nursing, and even semi-automated surgery.

Muragaki — director of the Center for Advanced Medical Engineering Research and Development (CAMED) at Kobe University — and his team are working on a robot called AIREC (AI driven robot for embrace and care). Their goal is for AIREC to take over some physically demanding tasks, such as transferring patients to wheelchairs or assisting them with walking.

The researchers hope that one day AIREC might even perform procedures such as ultrasound examinations and surgery in situations where access to medical care is limited.

Muragaki is now leading a team that has developed another technology called a smart cyber operating theater, which could offer a single medical device for diagnosis and therapy.

This technology is aimed at boosting interoperability between many stand-alone medical devices used in surgery. The idea is that "all devices are networked by middleware to integrate the data, and are robotically controlled to perform precision-guided therapies," Muragaki explains.

A patient's condition would be monitored and displayed in real time during surgery using an interface known as the 'strategy desk'. He plans to integrate this type of setting, incorporating technologies such as surgical navigation in conjunction with Medicaroid's hinotori™ Surgical Robot System which Masato Fujisawa, president of Kobe University, was involved in developing. Ultimately, Muragaki believes robots such as AIREC could help perform semi-automated surgery by 2040-2050.

Muragaki is just one of the researchers from Kobe University working on Japan's Moonshot Research and Development Program. This covers a wide range of research projects with nine ambitious goals designed to reshape the future.

▲ **Scientists from Kobe University have created a 'mouse metaverse' to study the changes in brain function networks..**

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Researchers at Kobe University are involved in two of these goals. The projects range from the robotic surgery under Goal 3: 'Coevolution of AI and Robots', through to projects on understanding the human mind, and identifying a biomarker related to mental health under 'Goal 9: Increasing Peace of Mind and Vitality'.

ALL IN THE MIND

As a Program Manager of Moonshot Goal 9, Toru Takumi, a professor at Kobe University's School of Medicine and director of the Center for Medical Transformation, is leading a project to develop a neuroscientific basis for visualization and manipulation of the mind.

Takumi originally trained as a molecular biologist. While he was working in a lab studying circadian rhythms, he became interested in the role of genetics in governing our body clocks. This led to an interest in higher brain function, and the biological mechanisms behind our decision-making processes.

"Psychologists study the mind by asking people questions. But we are trying to understand the mind biologically which is very difficult," he says.

To gain a better understanding, he developed a virtual reality (VR) system to observe the dynamics of functional brain networks in mice when they are given various sensory stimuli[1].

He and his team have further developed an interactive social system by combining two of the mouse VR systems to create a 'mouse metaverse' where they can observe the changes in brain function networks in response to social behaviour.

While this research demonstrates the relationship between the cortical network and behaviour in mice, Moonshot Goal 9 is focused on the human mind.

"THE BIG QUESTION IS HOW WE CONNECT TO THE HUMAN MIND, AND THIS IS CHALLENGING."

"Potentially our mind is generated from a complex neural network in the brain. The VR system allows us to see the cortical network. Although what we see in the mice is not the mind, it is the resulting behaviour, and we need to interpret from the behaviour what is happening in the mind," says Takumi.

The team's results, combined with other data, hint that an important brain region driving behaviour is the medial frontal cortex, near the front of the brain. "We want to know the connections between the medial frontal cortex and other cortical regions," Takumi says.

While the project will conclude in March 2025, the researchers are discussing plans for a second phase and how to interpret the data from the mouse experiments to better understand the human mind.

"The big question is how we connect to the human mind," says Takumi, "and this is challenging."

FINDING BIOMARKERS

Also supported under Moonshot Goal 9, Akitoyo Hishimoto's project focuses on identifying biomarkers related to mental health and suicidal ideation.

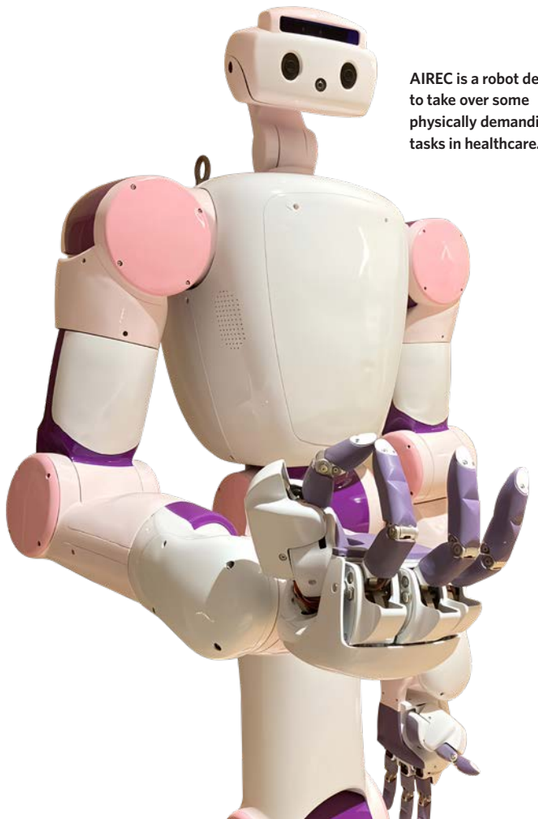
Hishimoto, a professor at Kobe University's School of Medicine, has a background in genetics and epigenetics in psychiatry. He says the new project is a response to an increase in youth suicide in Japan. While recognizing that there are many aspects to the issue of suicide, this project is investigating the problem from a genetics perspective.

"We are studying the links between suicide and genetics," says Hishimoto who has been researching the subject for 20 years and is part of the recently formed International Suicide Genetics Consortium[2].

Using epigenetics studies, his team is trying to identify a biological marker for stress. Their previous research has shown aberrant biological ageing and immune abnormalities due to severe psychological stress in suicide cases[3].

"If our project can establish the relationship between these biological indicators, which include epigenome and single-cell level gene expression changes, epigenetic age and telomere length, it is possible to reverse the biological changes caused by suicidality through intervention," he says.

These projects, which seek to solve problems both in physical and mental wellbeing, could transform the way we approach caregiving, and put Japan in a leadership role in shaping the future of healthcare. ■



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AIREC is a robot designed to take over some physically demanding tasks in healthcare.

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