Non-Invasive BMI for Estimating Mental and Physical State

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IoB Interface

Moonshot Research and Development Program Goal 1 Kanai Project

Overview

The IoB Interface aims to popularize Brain-Machine Interface (BMI) technology by developing techniques to extract thoughts and mental states from brain activity using various devices and implementing them in society as applications. Specifically, we are developing algorithms that can quickly extract thoughts and mental states in daily environments by combining gadget-type EEG sensors, like headphones, with mobile phone camera images, among other data. By using these, we aim to proliferate BMI technology in society by creating applications that enable self-regulation through the visualization of daily physical changes that are not consciously recognized, and applications that support communication for users whose intentions cannot be externally expressed due to their condition or situation. The Ushiba Group, in particular, is promoting the creation of 'daily life with BMI' by developing small, wireless, and quickly attachable EEG sensors, along with AI filters that automatically separate the diverse noise encountered in real-world environments.

Compact, Wireless, and Quick-to-Apply EEG Sensor

Easy, Accurate EEG: Anytime, Anywhere

We all face moments when our mind and body don't move as intended, despite our best efforts—functional impairment of the mental or nervous system due to life events like aging, accidents, or injuries can happen to anyone. The wearable EEG sensor we are developing aims to visualize these mental and neurological issues and enable self-regulation.

Our proprietary device housing is meticulously engineered to allow anyone to easily and medically accurately record brainwaves, much like wearing a pair of headphones. The product features a stylish design that blends seamlessly into the urban environment. It incorporates ground and reference electrodes that naturally fit behind the ear and on the cheek. A length-adjustable headband ensures the electrodes are precisely positioned over the 'Central Region'—the critical brain area governing motor skills, sensation, cognition, and arousal. Furthermore, by integrating a spring mechanism in the electrode holders and utilizing a specialized sponge and proprietary lotion, we have achieved a skin-electrode impedance of less than 30 kΩ in just 30 seconds for any user.

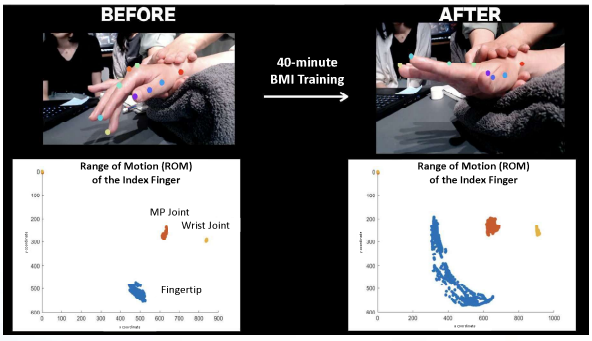
We believe this innovative technology will significantly accelerate the widespread public adoption of scientifically validated, wearable Brain-Computer Interfaces (BCIs).

Self-Care for the Brain

Some individuals, even after suffering a stroke and completing medical treatment to return to society, continue to struggle with fixed, persistent paralysis. By combining our newly developed EEG sensor with AI embedded in a tablet PC, we can visualize the activity of the neural circuits when the user attempts to move in real-time. Through training to self-regulate this activity, users can learn how to apply and release muscle tension, leading to a significant improvement in the range of motion of their fingers and hands.

Previously, it was difficult to directly capture the state of the "brain," which acts as the body's controller. However, with this EEG sensor, it will now be possible to directly visualize the motor signals emanating from the brain and use them for training.

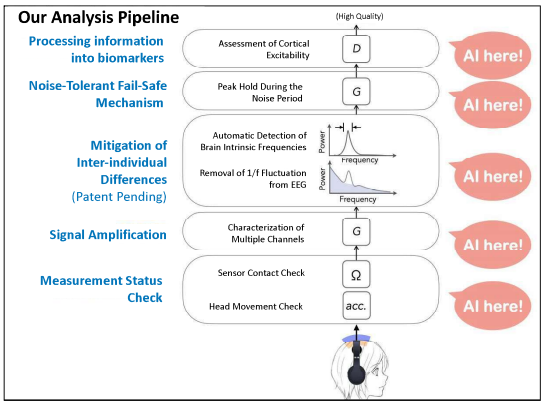
We are currently promoting efforts to expand the application of this technology not only to stroke rehabilitation but also to other diseases such as Dystonia and Parkinson's disease.



EEG Sensor Training for Motor Signal Output in Chronic Stroke Patients.

Protecting Brain Signals from Noise with AI

As brainwaves are extremely faint signals, measured in just a few microvolts, they are susceptible to diverse noise contamination for various reasons. We have made a science of this "noise," developing a technology that applies AI to each noise component for fully automated signal cleansing. We utilize an AI engine capable of analyzing scalp EEG with physiological quality, even in real-world environments.



Signal Quality Assurance via ML/Statistical Modeling Optimized per Noise Process.

Race Your Avatar with Your Brainwaves!

To verify the performance of our developed EEG sensor and AI technology, we offered over 2,200 visitors a "brainwave-controlled avatar" game experience over 10 days at the Osaka-Kansai Expo. The technical success of achieving one-touch, 30-second EEG measurement for every single participant was significant. More importantly, this futuristic experience of controlling an avatar with brainwaves helped widely demonstrate the contribution of BMI technology to realizing a society where everyone can connect, regardless of disability.

Highlights of the 10-Day BCI Brainpic Experience Exhibition (Starting Aug. 20, 2025)

Future Prospects

We aim to realize a future society where individuals facing difficulties in daily life due to brain or physical constraints can be supported by AI-driven BMI (Brain-Machine Interface) technology and avatar control technology. To this end, following appropriate review and approval processes, we will proceed with the intellectual property transfer to LIFESCAPES Co., Ltd.—the BMI manufacturer I founded and concurrently serve at—and other partner companies, to promote sustainable commercialization both domestically and internationally. Through these efforts, we will deepen the science of the brain and AI, and cultivate the next generation of talent knowledgeable in the harmonization of science and business.

Junichi Ushiba

Professor, Faculty of Science and Technology, Keio University

Born July 8, 1978, in Tokyo. Graduated from the Faculty of Science and Technology, Keio University, in 2001. Obtained a Ph.D. in Engineering in 2004. In the same year, appointed as Assistant in the Department of Biosciences and Informatics. Subsequently served as Lecturer (from '07), Associate Professor (from '12), and Principal Investigator at the Institute of Basic Science and Fundamental Engineering (from '14 to '18), before becoming a Professor in 2022. Concurrently serves as President and Representative Director of LIFESCAPES Inc., a venture company utilizing research outcomes (since '19). Accolades include being a Top 10-12 Nominee for The BCI Research Award in 2024, 2019, 2017, 2013, 2012, and 2010, and receiving The Young Scientists' Prize from the Ministry of Education, Culture, Sports, Science and Technology (FY2015, for research on Neural Medicine using Brain-Machine Interface), among others.

Internet of Brains

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