IoB Middleware

Moonshot Research and Development Program Goal 1 Kanai Project

X Communication

CRO & Head of R&D Department, Araya inc. / Moonshot Goal 1 Kanai Project SPM
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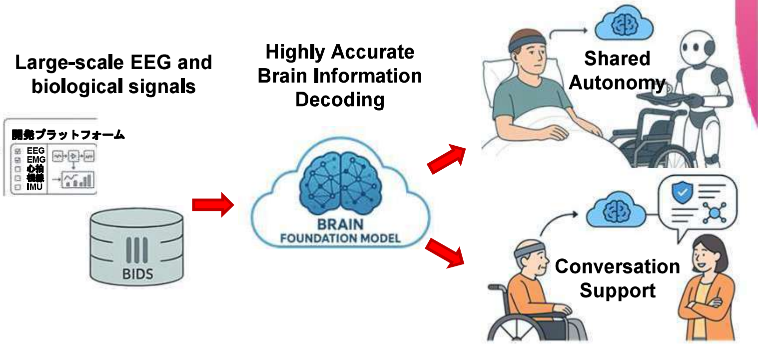
Overview

By collecting large-scale EEG and biological signals without invasive surgery, we aim to develop AI that accurately predicts users' "intentions" and create systems that autonomously support daily living. This technology seeks to build a society where everyone, including those who find physical operation difficult, can live free from limitations.



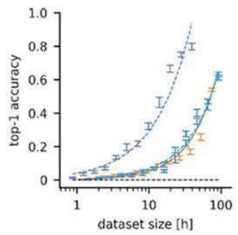
Discovery of Scaling Laws in Speech Decoding Using EEG

Electroencephalography (EEG) is a representative non-invasive measurement technique. Its potential for wearable implementation has led to its widespread use in research as a sensing device for Brain-Machine Interfaces (BMIs). However, because EEG signals are measured from the scalp, they contain various noise from body movements and the surrounding environment. Consequently, practical applications for decoding highly complex brain information, such as speech, have been considered difficult.

Recently, it has been shown that the accuracy of AI systems, such as Large Language Models (LLMs), follows an empirical rule known as the scaling law, where performance improves with the amount of data used for training. However, it was unknown whether this scaling law applied similarly to EEG decoding. To address this question, the X Communication team (Araya Inc.) trained an AI using over 400 hours of EEG data recorded from the same subject while reading aloud. They successfully achieved 60-80% accuracy in correctly identifying 512 speech segments from the EEG data.

High-Density EEG / Dense array EEG

Decoding accuracy improves with training data



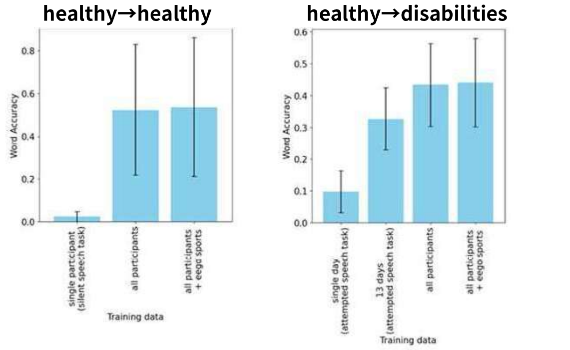
Building a Scaling-Law-Driven EEG Data Infrastructure

～Improving Speech Decoding Accuracy for Individuals with Disabilities Using EEG Data from Others～

The discovery of scaling laws suggests that accumulating large-scale data enables highly accurate and flexible brain information decoding using EEG. However, EEG data exhibits significant variability between subjects, and it was unclear whether a model trained on EEG data from one cohort could generalize to other individuals. This study, however, demonstrates that only a small amount of data from a target individual, supplementing it with EEG data from other people can improve speech decoding accuracy. Moreover, this improvement is observed not only among healthy individuals but also between healthy subjects and patients with severe neurological disorders who are largely unable to speak or move. This suggests that building a large-scale EEG data platform could greatly reduce the initial burden of adopting BMI technologies.

Improving accuracy using other subjects' data

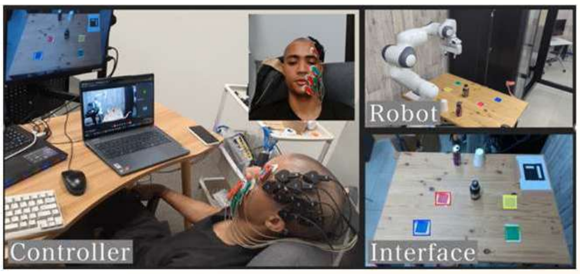
healthy→healthy / healthy→disabilities



※Results of measurement using the cEEGrid (16 electrodes around the ear), a simple device designed for daily use.

Remote Control of a Robotic Arm Using High-Density EEG

The X Communication Team and Reinforcement Learning Team (Araya Inc.) have successfully operated a robotic arm remotely using ultra-high-density EEG and AI. In this study, we trained AI to predict spoken color names from EEG signals and to guide the robotic arm to target points corresponding to the predicted colors.. Additionally, imitation learning was employed to achieve remote operation of the robotic arm.



Future Prospects

Currently, achieving high-accuracy speech decoding requires speech-like movements (even without vocalization), similar to lip-syncing. Furthermore, it remains unclear whether decoding is possible in environments involving significant body movement or high ambient noise. Moving forward, we will focus on developing middleware technology that enables stable decoding without the need for speech movements, even in environments with significant body movement or high ambient noise.

Shuntaro Sasai, Ph.D

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He received his Ph.D. from the Graduate School of Education at the University of Tokyo in 2013 (accelerated completion). He subsequently moved to the United States and joined the University of Wisconsin–Madison School of Medicine as a research fellow, where he investigated the neural mechanisms of consciousness. Working closely with the proponent of the Integrated Information Theory (IIT) of consciousness, he contributed both to the refinement of the theoretical framework and to its empirical validation. His work led to the identification of brain regions corresponding to the neural substrates of consciousness. After returning to Japan, he joined Araya, Inc. in November 2020 and has held his current position since October 2021. He is currently engaged in foundational research at the intersection of neuroscience and artificial intelligence, as well as in the development of novel neurotechnology products that apply consciousness theory toward the societal implementation of "mind-connecting" brain–machine interfaces (BMIs).

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Internet of Brains