



T.C.SAĞLIK BAKANLIĞI
SBÜ GAZİLER FİZİK TEDAVİ
VE REHABİLİTASYON EAH

NeuroMotion

Motion Intention Detection, Artifact Labeling, and EEG Visualization using Artificial Intelligence

Utku Eyerci - Lütfiye İrem Dila Çalık - Murat Tut
Şemsettin Ekin Işık - Ahmet Burak Albayrak

Dr. Sevgi Koyuncu Tunç

Çankaya University, Department of Software Engineering



TÜBİTAK



Company Info

This project was developed by senior engineering students from the Çankaya University Software Engineering Department under academic advisement and supervision using a multidisciplinary approach. The study combines **signal processing hardware, artificial intelligence backend architectures, and 3D simulation** technologies. Aiming to generate AI-supported local solutions in the fields of healthcare and human-computer interaction, this innovative academic study provides a secure software infrastructure for future wearable and assistive technologies.

Project Scope and Objective

Although brainwaves (EEG) contain critical information about human intention, they cannot be directly interpreted or used in their raw form within control systems due to being inherently weak, noisy, and highly subject-dependent. The NeuroMotion project was developed to transform these complex signals, which are easily contaminated by external factors such as eye blinks or muscle movements, into meaningful digital commands using artificial intelligence. The primary objective of the project is to present an integrated prototype that provides direct and secure control via brainwaves, eliminating the need for physical controllers like keyboards, mice, or joysticks for motor-impaired individuals or next-generation interaction systems.

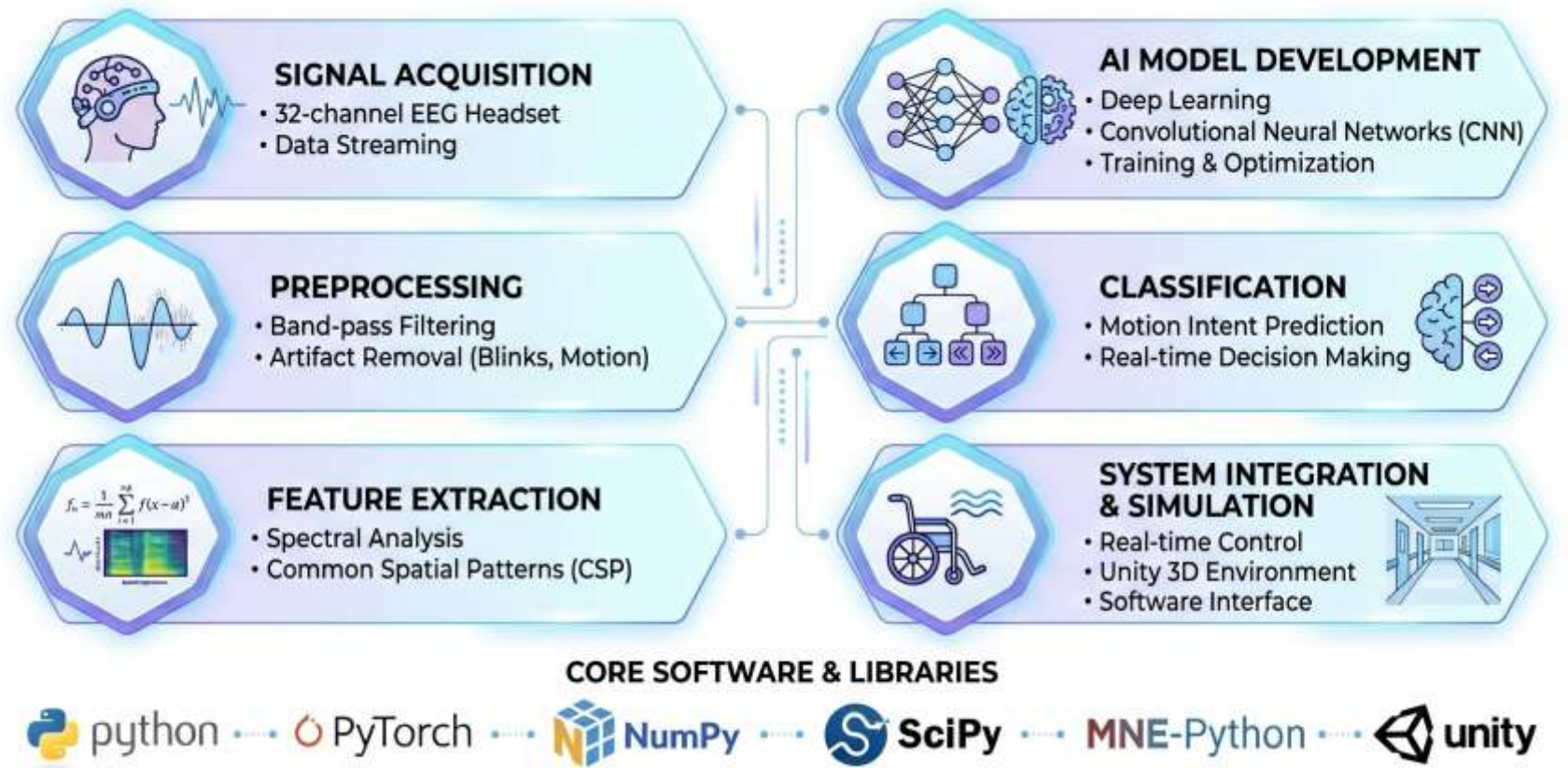
System Architecture and Data Acquisition

To acquire the fundamental data of the system, an advanced multi-channel hardware infrastructure capable of scanning the motor cortex with high precision was utilized. Within the scope of the experimental protocol specially designed for the project, both the physical movements executed by the participants and the motor imagery where they only visualized these movements in their minds were recorded synchronously. By executing an innovative and dynamic test scenario that prevents users from anticipating subsequent steps, the artificial intelligence was enabled to learn purely focused motion intentions, entirely free from memorized patterns.



Signal Preprocessing and Model Development

To ensure the collected brain signals are seamlessly interpreted by artificial intelligence, an advanced signal filtering architecture was established to extract all biological and environmental artifacts. Through modern AI and deep learning modeling applied to the filtered data, hidden patterns and intentions during the moment of thought were classified with high accuracy. The system was engineered to deliver a real-time, fluid, and secure user experience; simultaneously, to ensure the absolute safety of user data carrying clinical sensitivity, an offline, encrypted, and entirely locally operating software infrastructure was designed.



Results and Conclusion

- AI and Model Performance:** NeuroMotion proved the efficacy of artificial intelligence models by achieving high classification success rates on data obtained from participants, both in physical movement intentions and purely thought-based tasks. The spatial-filtering-based machine learning algorithms and motor-rhythm-sensitive deep Convolutional Neural Network (CNN) architectures trained within the project reached high accuracy rates of up to **86.5%** in mental focus tasks and up to **83.3%** in physical execution tasks.
- Real-Time Simulation Integration:** The highly confident AI commands obtained were successfully integrated into a custom-designed 3D hospital simulation environment via a real-time data protocol. Users successfully controlled a wheelchair within the simulation smoothly, safely, and intuitively using only their brainwaves.
- Future Vision and Outcomes:** This developed integrated system demonstrated that brain-computer interface (BCI) technologies can safely move beyond laboratory environments and be confidently applied to realistic scenarios. Consequently, a robust software prototype with high commercial potential has been achieved for future assistive healthcare technologies and accessible living solutions.

