NeuroMotus: An Intelligent Exoskeleton System to Improve Cerebral Palsy Patient Mobility Using Brain Computer Interface

Ahluwalia, Ishan (School: Jesuit High School)

Cerebral palsy (CP) is a neurological disorder that affects 18 million individuals worldwide. The debilitating condition leaves patients with severely impaired mobility due to spasticity or muscle hypertension. Exoskeletons, external mobility devices, have provided promise for a future where CP patient mobility is restored. However, their applicability is currently limited to clinical settings because they give fixed assistance unsuitable for many essential movements and create a competing relationship with the patient's muscles. My project, NeuroMotus, is designed to solve these challenges by predicting patient movements via brain-computer interface and providing exoskeleton assistance through angular data. For prediction, my system utilizes intent signals, which are intact for CP patients, to predict upcoming movements. These signals were captured and trained through a procedure that isolates the 2 seconds before voluntary movement, known as bereitschaftspotential (BP). A custom EEG head cap was developed to collect the BP data with 5 optimal electrodes placed across the brain's motor cortex. Using a convolutional neural network trained on the BP data of 5 essential movements of daily life, my algorithm achieved an overall 87% accuracy. From there, my system optimizes exoskeletons for these new movements in real time through a closed-loop system that detects movement intent, calculates the required angular rotation, and sends the information to a mock exoskeleton. Ultimately, Neuromotus aims to broaden the mobility range of CP exoskeletons and help create a harmonious patient-device relationship, providing a promising opportunity to improve CP patient lives in the real world.

Awards Won:

Central Intelligence Agency: First Award: $1000 award

Second Award of $2,000