Brain-machine interface-based neurorehabilitation for stroke motor/cognitive impairment

We aim to develop a brain-machine interface for stroke motor rehabilitation that automatically detects cortical motor commands from the EEG signal of the patient and controls the pneumatic exoskeleton robot attached to the patient's hand. The patients are encouraged to move the paralyzed hand along with the hand motor video to facilitate their impaired motor cortex. The exoskeleton moves the hand of the patient only when the motor cortex of the patient could produce the right signal at appropriate timing with the desired strength, the patient could learn how to produce a cortical motor signal which is similar to the healthy people. These self-trainings of the motor cortical activity help reorganize the central-peripheral motor circuit. We are collaborating with doctors and therapists in the hospital and we can evaluate our BMI prototypes with the help of actual stroke patients in their recovery stages. Our previous system did confirm its ability to derive functional recovery in severely paralyzed patients, for whom there had been not so many rehabilitation methods available so far. We are now improving the function of the system to evaluate the state of the patient more accurately, improve the efficiency of the training by combining the BMI and brain electrical stimulation, or incorporate a VR environment in the system to provide the patient with more motivation for training. Another ongoing research is to develop a mobile app to perform BMI rehabilitation at the home of the patients or rehabilitation facilities like daycare. You can develop an excellent skill to design an online BMI system including software and hardware. You can also learn EEG signal processing.

Suggested readings:

Ono, Y., Wada, K., Kurata, M., & Seki, N. (2018). Enhancement of motor-imagery ability via combined action observation and motor-imagery training with proprioceptive neurofeedback. *Neuropsychologia*, 114, 134-142.

Wada, K., Ono, Y., Kurata, M., Ito, M. I., Minakuchi, M. T., Kono, M., & Tominaga, T. (2019). Development of a brain-machine interface for stroke rehabilitation using event-related desynchronization and proprioceptive feedback. *Advanced Biomedical Engineering*, 8, 53-59.

Ono, Y., Wada, K., Seki, N., Ito, M., Minakuchi, M., Kono, M., & Tominaga, T. (2018, October). Hand motor rehabilitation of patients with stroke using physiologically congruent neurofeedback. In *2018 IEEE International Conference on Systems, Man, and Cybernetics (SMC)* (pp. 39-44). IEEE. (Invited symposium paper)