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EEG-based control of a hand orthosis in tetraplegic patients

Gert Pfurtscheller

It has been shown that tetraplegic patients can learn to modify cortical oscillations in the alpha- and beta band to operate a hand orthosis (Pfurtscheller et al. Neurosc. Lett. 292, 211-214, 2000). Mental imagination of a specific movement can modulate the EEG . By online analyzing and encoding the brain signal in real time a control signal can be generated and used to control the opening and closing of a hand orthosis. Such a system is known as Event-Related Desynchronisation (ERD)-based BCI. The main advantages and disadvantages of ERD BCIs are: They are independent of any stimulation and can be operated at free will. The main disadvantage, however, is that the training is very time-consuming, can last many weeks and months. Moreover not all users are able to obtain control of their brain waves after intensive training.

Recently it was demonstrated that orthosis control can also be realized with a Steady State Visual Evoked Potential (SSVEP)-based BCI via gazing e.g. at a 8-Hz flashing light (LED) to open and e.g. at a 13-Hz LED to close the orthosis (Ortner et al. IEEE TNSRE 2010 in press). In this case the patient has to focus visual attention to one of the flickering lights to operate the orthosis. The main advantages and disadvantages of SSVEP BCIs are: They require minimal training, can be set-up easily and very fast, can be realized with only one EEG channel and can achieve a high information transfer rate of up to 60 bits/min. The main disadvantage however, is that those systems require permanent attention to external stimuli which may be fatiguing for some users.

In the presentation both techniques (ERD-based and SSVEP-based BCIs) are discussed and a new approach the “hybrid BCI” is introduced (Pfurtscheller et al. IEEE TNSRE 18/4, 409-414, 2010).