Abstract:

Human–Machine Systems (HMS) can read aspects of human brain activity if linked to this by means of Brain–Computer Interface (BCI). This connection can be established by a combination of methods of machine learning and given knowledge about the interpretation of the electroencephalogram (EEG). The resulting technology allows for automated analyses of brain activity in real time and can also be utilized to provide input commands for a technical system. In the past two decades, researchers have investigated BCIs mainly for the purpose of defining assistive technology for people with severe disabilities, leading to new channels for communication and control.

I will talk about a new endeavor in this field – the application of BCIs in HMS that are operated by users without disabilities. Based on the state–of–the–art in BCI research I have identified unreliability, limited bandwidth of information transfer, high cognitive effort and cumbersome and time–consuming preparation as the main problems BCIs have to face in real world applications outside the laboratory. To address these problems, I have introduced a newly developed framework extending a categorization of contemporary BCI systems with passive BCIs. Contrary to classic BCI systems, these do not aim at directly controlling a system by commands sent intentionally by the user. Passive BCIs access information about covert aspects of user state and making it available to the machine, with the aim of enhancing the given interaction. Combining it with recently introduced hybrid BCIs leads to the introduction of context–aware BCI–systems, incorporating larger portions of the available information space to increase the reliability of the global system.

In the first part of my talk I will briefly present 5 studies that are embedded in current HMS research topics. These studies can be seen as examples showing that passive and context–aware BCIs can indeed deliver valuable information about the user state, like information about intentions or internal
interpretations, even if the bandwidth and reliability of the given BCI channel is restricted. I will discuss that passive BCIs can be added to a given HMS without increasing the effort of using the system, as such information channels inherently do not need attention of the user. I will talk more detailed about a passive BCI for error detection that is universally applicable for any user, without the need for time consuming individual calibration.

These studies show that BCI technology can indeed be valuable for contemporary research in the field of HMS as they validate that problems in safety and automated adaptation, as well as the well known Midas–touch problem in touchless interaction can be solved in an efficient way by utilizing the novel BCI concepts. Following up on that I will present how this technology can also be used in the field of Computational Neuroscience by discussing a study about detecting bluffing in a game context.

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