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Applications and Issues of Brain Computer Interface and Advancement in Neuroscience

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DESCRIPTION

Brain computer interfaces (BCI) are devices that allow direct communication between the brain and a computer or other external device. They provide a greater degree of freedom by either strengthening or substituting human peripheral working capacity and have potential applications in a variety of fields including rehabilitation, affective computing, robotics, gaming, and neuroscience. Significant global research efforts have resulted in common platforms for technology standardisation, assisting in the resolution of highly complex and non-linear brain dynamics, as well as related feature extraction and classification challenges. Another challenge for BCI researchers is to transition the technology from laboratory experiments to plug-and-play daily life. This review summarises the most recent advances in the BCI field and highlights critical challenges. Brain computer interfaces (BCI) are devices that allow direct communication between the brain and a computer or other external device. They provide a greater degree of freedom by either strengthening or substituting human peripheral working capacity and have potential applications in a variety of fields including rehabilitation, affective computing, robotics, gaming, and neuroscience. Significant global research efforts have resulted in common platforms for technology standardisation, assisting in the resolution of highly complex and non-linear brain dynamics, as well as related feature extraction and classification challenges. Another challenge for BCI researchers is to transition the technology from laboratory experiments to plug-and-play daily life. This review summarises the most recent advances in the BCI field and highlights critical challenges. Many factors influence BCI performance; taking the underlying cortical-subcortical networks into account is critical. MI-induced signals, for example, are best recorded from premotor and motor areas because the premotor cortex, primary motor cortex, and supplementary motor area, as well as the basal ganglia and thalamus of the subcortical areas, are the most activated during MI (Marchesotti et al., 2017). While EEG can detect premotor and motor area activation (Edelman et al., 2015; Saha et al., 2019a), intracortical electrodes can detect basal ganglia and thalamic activity (Sand et al., 2017).Emotional and mental processes, neurophysiology related to cognition, and neurological factors, such as functions and anatomy, all play important roles in BCI performance and contribute to significant intra- and inter-individual variability (Saha and Baumert, 2020). Attention, memory load, fatigue, and competing cognitive processes (Gonçalves et al., 2006; Käthner et al., 2014; Calhoun and Adali, 2016) influence instantaneous brain dynamics, as do users' basic characteristics such as lifestyle, gender, and age (Kasahara et al., 2015). Individuals with lower empathy, for example, participate emotionally less in a P300-BCI paradigm and can produce higher amplitudes of P300 waves than subjects with greater empathetic involvement (Kleih and Kübler, 2013). P300-BCI performance is also related to motivation (Nijboer et al., 2010).The intrinsic neurophysiological instability of brain dynamics poses significant challenges to the efficiency of BCI systems. A BCI system's main components are signal acquisition, signal processing, and effector devices (Schwartz et al., 2006). Various neuroimaging techniques have been used to investigate cortical activities using either electrical or hemodynamic signatures (Min et al., 2010), but none of the methods show any advantage for a profitable BCI design that meets the four important criteria: cost efficiency, portability, ease of maintenance, and little or no surgical involvement. When compared to other signal acquisition modalities, EEG-based BCI is more compliant with the aforementioned criteria. Tables 2 and 3 present a variety of BCI applications that make use of EEG. Both invasive and non-invasive signal acquisition have recently demonstrated long-term reliability.Numerous breakthroughs in neurosensors and computational tools herald great hope for more sophisticated and user-friendly BCI systems that require

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no or little maintenance. Aside from high-fidelity signal acquisition, significant progress in signal processing and machine learning tools, their complementary roles, high computation power, and increased computer mobility have all contributed significantly to the emergence of BCI technologies.

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CONFLICT OF INTEREST

The author's declared that they have no conflict of interest