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The Evolution of Brain-Computer Interfaces: From Medical Rehabilitation to Mainstream Consumer Electronics

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Abstract: *A Brain-Computer Interface (BCI) is a technology that establishes a direct connection pathway between human brain activity and external devices. This system is revolutionary because it allows for communication and control without relying on any peripheral muscle movement. This paper explores the significant evolution of BCI technology. It traces its development from its origins in medical rehabilitation, where it served patients with severe motor disabilities, to its current expansion into the realm of mainstream consumer electronics. The paper highlights the core methods of signal acquisition, processing, and translation, which are the foundational processes that enable brain signals to control complex external devices such as prosthetics, wheelchairs, or various digital systems. Furthermore, emerging BCI applications are discussed, including those in immersive gaming, smart devices, and deep integration with artificial intelligence. Finally, the paper addresses the critical ethical challenges inherent in this technology, such as user privacy, data security, and the potential for societal inequality, to provide a comprehensive understanding of how BCI has evolved from a specialized medical tool into a major step in human-machine interaction.*

Keywords: Brain-Computer Interface (BCI), EEG, Rehabilitation, Consumer Electronics, Neurotechnology, Ethics

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