Chapter 8
Revolutionizing Interaction Brain-Computer Interfaces for Real-Time, Data-Rich Secure Communication

S. Nagarajan
https://orcid.org/0009-0008-3455-442X
Department of CSE, Shri Vishnu Engineering College for Women, India

N. M. G. Kumar
https://orcid.org/0000-0003-1494-5737
Department of EEE, Mohan Babu University Sree Vidyanikethan, India

Adlin Sheeba
https://orcid.org/0000-0002-7428-8575
Department of CSE, St. Joseph's Institute of Technology, India

R. Manikandan
https://orcid.org/0000-0002-2055-6634
Department of Electronics and Communication Engineering, Panimalar Engineering College, India

Ravi Kumar Saidala
https://orcid.org/0000-0002-3658-6651
Independent Researcher, India

G. Manikandan
Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, India

Mukundan Appadurai Paramashivan
https://orcid.org/0009-0009-5608-4788
Champions Group, Singapore

ABSTRACT

The transformational potential of Brain-Computer Interfaces (BCIs) in facilitating immediate and data-rich communication is extensively investigated. A paradigm

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change is represented by brain-computer interfaces (BCIs) since they provide direct communication paths between the human brain and external objects, going beyond the conventional input patterns. In this study, improvements in brain-computer interface (BCI) technologies are investigated, with a particular focus on their ability to read neural signals quickly and directly. By utilizing these characteristics, BCIs have the potential to revolutionize the modes of business, thereby improving the efficiency of communication and making it more accessible to individuals with impairments and beyond. A review of the existing techniques and specialized fabrics that are supporting the development of BCIs is presented in this paper. Particular attention is paid to the incorporation of these methodologies into real-time operations as well as their counterarguments for future communication interfaces.

INTRODUCTION

Within the realm of human-computer trade, brain-computer interfaces, which are more commonly referred to as BCIs, have emerged as a game-changing technology. This technology provides the ability to investigate how humans communicate with and moderate bias that comes from the outside environment (Pandey, B. K. et al., 2024c). Brain-computer interfaces, often known as BCIs, can make direct connections between the human brain and computers. This is in contrast to typical input modalities, which must rely on physical interfaces (Tareke, S. A. et al., 2022) such as keyboards or touch screens. This direct neural interface may be able to permit communication that is both data-rich (Pandey, D. et al., 2024b) and carried out in real time. This will be accomplished by the process of rephrasing neuronal activity into orders that can be carried out without the need for motor responses. A significant amount of progress has been made in the development of brain-computer interfaces (BCIs) as a result of recent advancements in the disciplines of neuroscience, signal processing, and machine learning (Gupta, R. et al., 2023). The functions that these interfaces are expected to do include representing, interpreting, and restating brain inputs into digital commands that can control bias, communicate systems (Raja, D. Siva Sundhara et al., 2024), or even interact with virtual environments. These functions are supposed to be performed by these computers. It is not only that capabilities of this kind make communication more effective and secured (Pandey, B. K. et al., 2022), but they also make it possible for those who have severe motor impairments to engage with their surroundings on their own with new options.

Within the scope of this study, the current geography of brain-computer interfaces (BCIs) is studied, with a particular emphasis placed on the function that BCIs serve to fulfill in terms of supporting real-time wireless communication (Devasenapathy, D. et al., 2023) and managing huge volumes of image data (Maheshwari, R. U.