Chapter 8
Revolutionizing Communication:
EEG-Based Brain-Computer Interface for Speech and Mood Detection

Muhammad Usman Tariq
https://orcid.org/0000-0002-7605-3040
Abu Dhabi University, UAE & University College Cork, Ireland

ABSTRACT

This chapter examines the revolutionary potential of brain-computer interfaces (BCIs) based on electroencephalography (EEG) to improve emotional understanding and communication. In-depth descriptions of EEG technology and its use in speech decoding and brainwave analysis for mood detection are given in this chapter. It explores the core ideas of EEG-based BCIs such as signal processing and acquisition and emphasizes how they are transforming communication and emotion interpretation. Important processes for converting speech and mood data from EEG signals are covered along with methods for enhancing the precision and dependability of these systems. In addition, the chapter includes case studies and practical applications that highlight the usefulness of EEG-based BCIs in areas like monitoring emotional health and providing assistive technology to people with communication impairments.

DOI: 10.4018/979-8-3693-7515-0.ch008

INTRODUCTION

Through its use in speech and mood detection, the field of Brain-Computer Interface (BCI) technology has emerged as a transformative force in communication in recent years. BCIs, which enable direct brain-to-device communication, represent a significant advancement in our comprehension of and interaction with neural processes. Electroencephalography (EEG), a method for measuring electrical activity in the brain, is at the heart of this technology. This chapter focuses on the speech and mood detection applications of EEG-based BCIs, which have the revolutionary potential to improve communication. Systems known as brain-computer interfaces (BCIs) enable the conversion of neural activity into commands that can be carried out by establishing a direct connection between the brain and an external device. BCIs provide a non-intrusive method of interacting with technology, in contrast to conventional communication strategies that rely on physical input. EEG is one of the most widely used neural signal acquisition techniques because of its high temporal resolution and relatively low cost (Gu et al., 2021). Various neural signal acquisition techniques make this innovation possible. By placing electrodes on the scalp, EEG-based BCIs record electrical activity in the brain. The brain then interprets these electrical signals by processing and analyzing them. EEG, for instance, is able to identify specific brainwave patterns that are connected to a variety of mental states, such as a state of relaxation, concentration, or emotional responses. EEG-based BCIs are especially useful in applications where traditional input methods are impractical or impossible because of this capability. It is impossible to overstate the significance of BCIs based on EEG in communication. Conventional specialized strategies, like discourse and composing, can be restricting or unavailable for people with extreme incapacities. EEG-based BCIs offer a promising option by empowering direct correspondence through cerebrum movement. The way people with conditions like amyotrophic lateral sclerosis (ALS) or locked-in syndrome interact with the world could be completely transformed by this technology. The development of communication aids for individuals with speech impairments is one important application of EEG-based BCIs. For instance, systems have been developed by researchers that let users use their brain activity to select words from a virtual keyboard or imagine speech. By decoding EEG signals associated with specific speech intentions using machine learning algorithms, these systems make it easier for users to communicate their thoughts and requirements. In addition, EEG-based BCIs are making significant progress in emotional monitoring and mood detection.

These systems are able to deduce emotional states like happiness, sadness, and anxiety by patterns of brainwave activity. This ability is useful in a variety of settings, including user experience design and assessments of mental health. According to Fan (2024), mood-aware interfaces, for instance, can adjust their responses in response