Chapter 5
Deep Learning Strategies for Analyzing EEG Signals in Emotion Recognition

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ABSTRACT

Emotions are vital in human communication, and EEG signals have become a potential method for detecting emotional states in real-time. Nevertheless, attaining a high level of precision in the identification of emotions continues to be a significant obstacle. Due to the emergence of deep learning techniques, there has been a growing desire to utilize these approaches for acquiring advanced characteristics in EEG emotion identification. This research makes a valuable contribution to the field of Human-Computer Interaction (HCI) medical applications. The purpose of this chapter is to offer a thorough examination of EEG emotion identification, specifically emphasizing the use of deep learning techniques. The initial focus of our study is a comprehensive exploration of the underlying principles and ideas presented in the existing literature. The primary objective of our research is to enhance the efficiency of emotion recognition models to provide more precise outcomes. This chapter offers insights into the most recent breakthroughs and potential areas for further inquiry.

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INTRODUCTION

Emotions constitute a fundamental aspect of human experience, influencing our feelings, behaviors, and communications. Emotion recognition points to the ability to identify and infer human emotions based on various such as countenance, vocal accent, physiological signals (like heart rate or skin conductance), and behavioral patterns. It involves understanding and categorizing emotions, often into basic categories like happiness, sadness, anger, fear, and disgust, but can also include more nuanced emotions or complex emotional states. Emotion recognition using EEG would involve using patterns of brain activity to identify and categorize specific emotional states. EEG offers a promising avenue to explore emotions by capturing brain activity, providing insights into the neural correlates underlying different emotional responses (Alarcão & Fonseca, 2019).

The field of emotion recognition has garnered significant attention in recent years, mostly because of its potential applications in healthcare, neuromarketing, and human-computer interaction. Electroencephalogram (EEG) is a highly promising technology for evaluating emotional states since it has a high temporal resolution and is directly linked to brain processes. This research investigates the utilization of deep learning techniques to analyze EEG signals with the aim of reliably and effectively identifying human emotions (Erat et al., 2024).

Deep learning, a subfield of machine learning, has demonstrated exceptional achievements in representing intricate patterns in data across various fields. Deep learning approaches in the context of EEG recordings can uncover complex patterns that may be challenging to identify using conventional signal processing methods. This paper explores different deep learning architectures, including Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and hybrid models that contain elements of both. It offers a detailed analysis of their abilities and constraints in the field of emotion recognition.

The examination commences by examining the essential attributes of EEG signals that are pertinent to emotional processing. This is then followed by a discourse on the necessary pre-processing measures to ready EEG data for deep learning applications. Following that, the research assesses various deep learning models that have been suggested for emotion recognition based on EEG data, emphasizing their performance measures, such as accuracy, precision, and recall, in different experimental configurations. Furthermore, this analysis thoroughly investigates the difficulties related to the implementation of these models, including handling data with many dimensions, requiring significant processing resources, and assuring that the models can be applied to diverse persons.