



Multimodal Emotion Classification Using Physiological Signals and Machine Learning Techniques


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ABSTRACT

Emotions play a vital role in shaping our behavior and decisions, influencing our physiological and mental state. Affective computing focuses on developing computer systems to understand and simulate human emotions. The method of emotion classification involves thorough collection, preprocessing, and modelling using advanced algorithms such as machine learning and deep learning. The review covers various techniques for emotion elicitation, self-assessment, preprocessing, and unimodal and multimodal classification, along with the utilization of physiological signals. The study examines openly available databases, emotion labels, feature extraction, feature selection, and feature reduction techniques used in emotion classification. This article focuses on physiological signals collected from wearable devices with sensors, including blood volume pulse, skin temperature, optomyography, and galvanic skin response. The goal is to highlight the latest advancements and identify opportunities for innovative machine learning, deep learning, and fusion techniques in classifying emotions.

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1. INTRODUCTION

Emotions are complex feelings that affect our physical and mental state, thoughts, and behavior. They play a crucial role in communication, social interactions, and decision-making. Emotional intelligence refers to the ability to recognize, manage, and use emotions effectively. The key aspects of emotion are subjective experience, physiological response, and behavioral response which depend upon the experience, reaction, and behavior in response to emotion. Affective computing is a field that focuses on developing computer systems that can understand, recognize, and simulate human emotions. It encompasses engineering science, social science, brain and psychological science, and computer science disciplines (Pei et al., 2024). Emotion classification is an essential area of research in human-computer interaction, especially as there is an increasing demand for automated emotion identification systems. Human-Computer Interaction (HCI) refers to the study of the interaction of computers and technological systems with human beings.

Emotions are a way of expressing oneself or a reaction to a situation in life. Emotions contain negative and positive outcomes which are associated with specific emotions. Positive emotions are attempts or intentions to include and are expressed and they are fueled by a desire for enjoyment. Positive emotions are interest, boredom, enthusiasm, laughter, action, empathy, and curiosity. Negative emotions on the other side attempts or intention to exclude is expressed and it is fueled by a fear of the others' action, and unknown. Negative emotions are apathy, fear, shame, hatred, regret, anger, and grief. Emotions are divided into basic and complex emotions in emotional psychology. Basic emotions are those emotions that are important for survival, and universal. They are mainly associated with facial expressions which are recognizable and happen automatically. Paul Ekman, Robert Plutchik proposed a different list of basic emotions (Gu et al., 2019). Some basic emotions are sadness, happiness, anger, fear, surprise, and disgust. Complex emotions are aggregate of two or more other emotions. On the other hand basic emotions are innate, and unmixed. Some complex emotions include love, guilt, worry, and pride.

The fundamental theory of emotions, which relies on discrete and dimensional emotion models, is utilized to define the types of emotions. Discrete emotions are the basic emotions which are joy, trust, fear, sadness, surprise, disgust, anger, and anticipation. The continuous emotions are two-dimensional with valence and arousal (Ahmad & Khan, 2022).

The global Emotion Detection and Recognition (EDR) Market size in 2024 was valued at \$57.25 billion and it is projected by the end of 2029 to be \$139.44 billion at a Compound Annual Growth Rate (CAGR) of 19.49% (Mordor Intelligence, 2024). The use of artificial intelligence, machine learning, and deep learning, along with wearable devices and intelligent systems, are the major factors driving market growth. Emotion elicitation is utilized to induce emotions, and the techniques used are images, games, music, video/audio, and virtual reality. Emotion sensing involves using physical and physiological signals to classify emotions. Physical signals include facial expressions, gestures, speech, and body posture, while physiological signals include Electroencephalogram (EEG), Electrocardiogram (ECG), Respiration, Skin temperature (SKT), Galvanic skin response (GSR), Photoplethysmography (PPG), and Eye tracking (ET) (Pal et al., 2021).

The inclusion criteria in the chapter are the physiological signals collected from wearable devices with sensors, such as blood volume pulse, skin temperature, optometry, and galvanic skin response. The chapter aims to highlight the advancements that have contributed to the field's growth and provide a comprehensive review of the current methods of emotion classification, which involve collecting, preprocessing, and modeling unimodal and multimodal emotion classification techniques using machine

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