

**Title:** Automatic assessment of pain based on deep learning methods: A systematic review

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**Summary:** This review focuses on the automatic assessment of pain, which is essential for designing effective pain management strategies. By leveraging automatic pain estimation systems, the goal is to reduce the reliance on subjective self-reporting and introduce more standardized and consistent methods for assessing pain. These systems aim to analyze various types of data, such as facial expressions, physiological signals, vocal cues, or textual information, to estimate pain levels objectively. Researchers have been using deep learning algorithms to analyze pain and extract meaningful information. The review discusses different deep machine learning models, methods, and data types used in developing a deep learning-based system for automatically assessing pain. To conduct the review, the authors searched digital libraries and identified 110 relevant publications. These publications were categorized based on whether they used single or multiple sources of information (such as video, images, or bio-signals) and whether they considered the temporal aspect of pain, considering how pain changes over time. The study mentions that using multiple sources of information, especially in clinical settings, is crucial for accurately estimating pain. It also highlights the importance of considering the temporal aspect of pain. To ensure reliable and meaningful outcomes, the authors recommend the implementation of robust evaluation protocols and interpretation methods. These measures provide objective and easily interpretable results, facilitating the practical application of automatic pain assessment systems. Moreover, the authors draw attention to the limitations of the currently available pain databases. They highlight the necessity of developing more comprehensive and diverse pain databases that can adequately support the development, validation, and practical utilization of deep learning models. By addressing these limitations, these models can serve as valuable decision-support tools in real-life scenarios, aiding healthcare professionals in effectively managing and treating pain.

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