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A Survey on Automated Pain Recognition and Assessment Using Multimodal

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***Abstract*:** *Practical pain assessment is essential in clinical practice. However, conventional methods for pain assessment depend primarily on patients' self-reports, which are not feasible for non-communicative individuals, such as neonates and unconscious patients. Automated pain recognition presents a viable alternative that utilizes multimodal approaches integrating physiological signals and behavioral patterns. This survey examines recent advancements in Artificial Intelligence-based pain assessment techniques. We review current methodologies, challenges, and applications in healthcare. Furthermore, we discuss critical limitations, including dataset availability and model interpretability. Finally, we propose future research directions to enhance automated pain recognition systems' accuracy and clinical integration.*

***Keywords*:** *Automated pain assessment, Pain recognition, Assessment, Artificial intelligence, Machine learning, Natural language processing, Deep learning, Robotic, Multimodal, Behavior signals, Physiological signals.*

1. Introduction

According to the International Association for the Study of Pain (IASP), pain is an unpleasant emotional and sensory experience that is associated with, or resembling what is related to, potential or actual tissue damage. As demonstrated by conditions such as neuropathic and psychogenic pain (which could arise even in the absence of direct damage to the tissue), this definition emphasizes the multifaceted nature of pain, which includes both emotional and sensory components [1, 2]. In clinical settings, self-reporting is the foundation of conventional pain assessment techniques. However, these techniques are inherently subjective and could be unreliable, especially for people with communication problems [3]. Automated pain recognition systems use Artificial Intelligence (AI), Machine Learning (ML), Deep Learning (DL), and computer vision for enhancing the accuracy, objectivity, and efficiency regarding pain evaluation [4]. As explained in [5], these automated systems are more effective and efficient. Latest developments in AI-driven pain assessment are used multimodal methods which examine several pain indicators, such as based (facial