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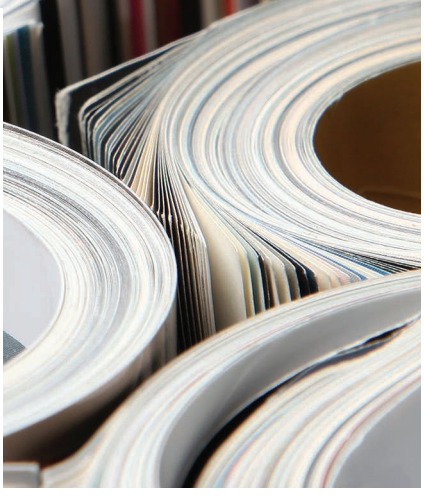

# Is Artificial Intelligence Able to Help With Pain Assessment?

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Most people are able to communicate in an expressive manner when they are in pain. But what about people who are not able to report their pain experience or whose expression of pain is hard to interpret? Examples include individuals suffering from dementia, patients developing delirium, and newborns. Techniques that provide a reliable assessment of pain experience are a prerequisite for effective pain therapy. Due to recent advances in the automated detection and analysis of behavioral cues, the question arises of whether these techniques may help assess pain-related states in a reliable manner.

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Physical pain is closely related to emotional states that may modulate the experience of pain and vice versa. Furthermore, principles and techniques from affective computing provide a solid basis for the automated analysis of pain-related states. Thus, it comes as no surprise that research on pain has increasingly attracted the interest of the affective computing community. This trend is also reflected by the increased number of submissions to *IEEE Transactions on Affective Computing* that focus on technologies to detect and monitor pain.

The article "Automatic Recognition Methods Supporting Pain Assessment: A Survey,"[1] by Werner et al., presents the state of the art in automated pain recognition, focusing on facial expressions, body postures and movements, paralinguistic and linguistic vocalizations, and physiological signals, alone and in combination (Figure 1).

People show a great deal of individuality in their expression of pain, and there is no clear mapping between behavioral cues and the intensity and quality of pain. This even goes for experimental settings in which pain is induced in healthy people under controlled laboratory


**FIGURE 1.** Examples of facial expressions associated with pain.[1]

conditions. Thus, considerable effort has to be spent to establish a "gold standard" against which to evaluate the performance of pain detection components. Various instruments have been developed to assess the experience of people in pain. The article describes clinically used pain assessment tools, such as self-reports and observational scales. It points out that representative data are required for developing and validating techniques for pain detection. To accelerate progress in pain research, a number of (to be announced) publically available databases, some of which (BioVid, SenseEmotion, and EmoPain) have been introduced in earlier issues of *IEEE Transactions on Affective Computing* or are in early access, are presented.

To provide the reader with a realistic sense of the potential, but also the limitations, of automated pain detection, this survey article reviews more than 100 papers on this topic, obtained by searching the Web of Science as well as the proceedings of major conferences and journals on biomedical informatics and artificial intelligence (including their reference lists). Particular challenges arise due to variations in behavioral expressions that are only indirectly related to pain. This article provides guidelines on paths to take to overcome existing challenges. Promising directions of research include approaches to incorporate knowledge of the context in which pain is observed and studies on the interaction of physical pain with other affective states.

## REFERENCE

1. P. Werner, D. Lopez-Martinez, S. Walter, A. Al-Hamadi, S. Gruss, and R. Picard, "Automatic recognition methods supporting pain assessment: A survey," *IEEE Trans. Affect. Comput.*, to be published. doi: 10.1109/TAFFC.2019.2946774.

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