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Pain Recognition from Finger Plethysmography using Neural Networks

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ABSTRACT

BACKGROUND: Pain is often mismanaged due to incorrect assessment of pain level. Currently, pain is evaluated with subjective methods only, such as pain questionnaires. It may lead to erroneous evaluation of pain level. For this reason, there is a need for objective pain evaluation.

OBJECTIVE: The aim of this study is to test different neural network architectures and different types of inputs derived from finger plethysmography to evaluate which type of network and input type is most suitable for objective pain detection.

METHODS: Photoplethysmogram signals were filtered, segmented into heartbeat pulses, and normalized in amplitude and duration. The fifty-three signal intensity and fifteen time-domain features were extracted from the pre-processed photoplethysmogram signal. Three different neural network architectures were employed with ten different types of input.

RESULTS: Results showed that feature-based models performed better than signal-based models. All three neural networks architectures achieved a mean accuracy of 0.85 for feature-based models and 0.76 for signal-based models. Multi-layer perception neural network with 12-heartbeats averaged showed the best performance with an accuracy of 0.92.

CONCLUSIONS: Feature-based approach and multi-layer perception neural network showed the highest accuracy, specificity, and sensitivity for pain recognition. Additional post-processing could increase model accuracy and may be used in future research.

KEYWORDS: pain, neural network, photoplethysmography, machine learning.