

PROCEEDINGS

Synergistic Interface Design for Intelligent EMG: From Soft Materials to AI-Driven Decoding

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ABSTRACT

Human motor function relies on the continuous coordination of neural drive, muscle activation, and mechanical output. As a key representation linking neural control to muscular activity, electromyography (EMG) has expanded from clinical diagnostics to a wide range of wearable applications, including prosthetic control, neurorehabilitation, and motion monitoring. With the development of flexible electronics, soft electrodes, and artificial intelligence, EMG systems are transitioning from short-term, static acquisition toward long-term, dynamic monitoring. However, in real-world scenarios, skin stretching and interfacial slippage, sweat infiltration, and interface aging induced by prolonged wear can perturb the electrode–skin contact condition, resulting in impedance fluctuations, signal drift, and feature distortion. These factors limit the long-term stability and decoding reliability of EMG systems. This review systematically summarizes recent advances in EMG technologies under dynamic conditions, with a particular emphasis on interfacial mechanical matching, adhesion stability, and environmental adaptability. The coupling relationships among interface stability, signal quality, and decoding performance are analyzed, and the advantages and limitations of machine learning and deep learning methods for processing non-stationary EMG signals are compared. Finally, it is highlighted that the coordinated development of interface engineering and intelligent decoding will be critical for enabling long-term stable EMG monitoring and its practical application.

KEYWORDS

Electromyography; wearable biosensors; flexible electronics; intelligent decoding; machine learning

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