Electrically Stimulated sEMG with Attention-Guided Bi-LSTM for Muscle Mass Level Classification

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Abstract

Sarcopenia, characterized by age-related loss of muscle mass and strength/function, is closely related to mobility, independence, and quality of life. Conventional assessments of muscle mass are constrained by portability, radiation exposure, and limited suitability for frequent monitoring. Therefore, we present a **non-invasive and** electrically stimulated surface EMG (sEMG) approach that captures evoked neuromuscular responses and classifies muscle mass level from brief recordings. sEMG was collected from rectus femoris and biceps femoris in **90 adults (20–59 years)** under **multi-frequency stimulation (5–25 Hz).** Pre-processing and class-imbalance handling improved data quality. A **bidirectional LSTM with an attention mechanism** modeled stimulus-locked temporal patterns, with demographic and anthropometric covariates integrated to enhance discriminability. In subject-wise evaluations, the model achieved its highest single-frequency performance at **25 Hz: 91.30% accuracy (F1-score 0.94)**, when **combining all frequencies,** performance reached **92.31% accuracy (F1-score 0.95)**. By eliminating voluntary exertion and avoiding radiation, this portable, stimulus-locked strategy enables rapid and repeatable screening in clinical and community settings. Electrically stimulated sEMG, combined with attention-based sequence modeling, may provide a practical and interpretable approach for muscle mass level assessment and could be considered for prospective clinical evaluation in sarcopenia risk stratification and personalized rehabilitation.

Keywords

Skeletal Muscle Mass, Stimulated Surface Electromyography (sEMG), Bi-LSTM, Attention Mechanism, Non-Invasive Assessment.

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