

ANALYSIS OF FACIAL ELECTROMYOGRAPHY SIGNALS FROM THE ZYGOMATICUS MAJOR MUSCLE DURING VARIOUS EMOTIONS USING MULTI-SCALE FLUCTUATION-BASED DISPERSION ENTROPY

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ABSTRACT

This study analyzes the complexity and variability of surface electromyography (sEMG) signal from the zygomaticus major (ZM) muscle during various emotions using multiscale fluctuation-based dispersion entropy (MFDE). BIOPAC MP 160 signal acquisition equipment is used to capture the facial EMG signals during the emotions - happy, sad, anger, fear, surprise, disgust, and neutral from 40 healthy subjects (100 signal samples) with effective facial expression capabilities. Time-domain and frequency-domain features provide valuable insights into a signal's characteristics. The conventional features Root Mean Square (RMS) and Mean Frequency (MNF) are used to study the muscle activation, strength, dominant frequency components, and motor unit recruitment patterns. The extracted features are analyzed to identify which emotions are more responsive to ZM muscle activity. Further analysis is conducted on facial EMG signals(fEMG) for these selected emotions using a complexity measure, MFDE. This method combines the concepts of coarse-graining and fluctuation-based dispersion entropy. A high entropy value reflects increased variability and irregular fluctuations of a signal, indicating higher signal complexity. The calculated MFDE is high for emotions surprise, happy and disgust, with entropy values of 23.68, 23.62, and 22.68, respectively, and the lowest for emotion anger, with an entropy value of 19.08. Findings reveal that the muscle ZM is more sensitive to the emotions surprise, happy, and disgust. Statistical analysis, such as repeated measures ANOVA and post-hoc comparisons performed to investigate the significant effect of emotions on the features. Hence, the proposed approach can be used for analyzing the variations of sEMG signals and extended to applications including affective computing and human-computer interface.

Keywords: Surface electromyography, Facial electromyography, Emotions, Facial expressions, Zygomaticus major, Multiscale fluctuation-based dispersion entropy

INTRODUCTION

Emotion is an integration of a person's physiological and psychological responses to external cues. Facial expressions are powerful non-verbal signs to convey emotions through the movement of facial muscles. Facial muscles play a crucial role in emotion recognition and are a group of muscles located under the skin. The zygomaticus major (ZM) muscle is a functionally significant muscle involved in facial