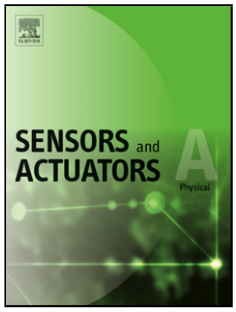

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Detection of Muscle Activation through Multi-Electrode Sensing Using Electrical Stimulation

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Abstract

The need to assess muscle activation and intention recognition in the design of prosthetic or exoskeleton robots has recently increased in rehabilitation medical research. Assessment of the muscle activation has an important role in the control of wearable devices. Such application requires estimating a patient's intention through the detection of their muscle activation. Previously developed techniques, namely, bioelectrical impedance analysis, electrical impedance myography, electrical impedance tomography, and a surface electromyogram, have been used in the detection of muscle activation. However, these techniques tend to have difficulty in assessing the muscle activation. A biopsy needle can be used to sense the muscle activation in an invasive manner. We propose a new method for detecting the muscle activation using multi-electrode sensing with electrical stimulation, but without a biopsy needle. Electrical stimulation is applied to the skin of a subjects forearm. The signals reflected from their muscles are then measured using multiple electrodes placed on the skin. The forearm skin and its muscles can be modeled as muscle tissue circuits depending on the signal frequency. We verified the proposed method experimentally through isometric muscle contraction, isotonic muscle action, and a frequency response test using various frequencies of the electric stimulation signals. Experiments with eight healthy subjects showed promising results in the detection of muscle activation, which can be applied to prosthetic or exoskeleton robots.

Keywords

Detection of muscle activation, multi-electrode sensing, electrical impedance, isometric muscle action, isotonic muscle movement.

1 Introduction

The number of patients who experience amputation, muscle weakness and paralysis increases when they get old or a complication in the status quo is developed. These phenomena require rehabilitation and muscle treatment supporting muscle activations. Their assessment methods play a large role in bridging prosthetic body parts and the