Preliminary Study on Finger Gestures for Surface Electromyograph (sEMG) based Number Recognition

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Abstract – Wide use of surface electromyograph (sEMG) has been made for efficient recognition of finger gestures due to its convenient to use and distinguishing signal patterns along finger movements. For high classification accuracy, it is important to have a consistent feature of sEMG signal feature for each finger gesture of a number. However, feature of sEMG signal for identical finger gesture can be different because of different muscle activation even in identical shape of gesture. Thus the experimental results in this work may motivate further study on how to make consistent muscle activation for a finger gesture at each try.

Keywords: Number recognition, Finger gestures, Surface electromyograph

1 Introduction

Surface electromyograph (sEMG) has been widely used in gesture recognition based application such as gross hand, wrist and arm movement recognition [1]-[3]. These movements provide consistent sEMG signals to distinguish sEMG activation patterns since gestures may accompany consistent engagement of the related muscles [1]-[2].

However, finger movement recognition is generated by flexion and extension of the individual thumb, index, middle, ring and little fingers whose are placed at three layers in the forearm [3]-[5]. Therefore, identical finger gesture may not always make consistent sEMG signals at every gesture. This possible inconsistency between finger gesture and sEMG signal brings motivation to this work.

To this end, this work carried out comparative study between sEMG signals from one paper in the literature and sEMG signal measured in this work for the same finger gesture. The comparative study tells that there were inconsistent sEMG signals even in identical finger gestures. This may motivate further research to set up guidelines for finger gestures with degree of muscle activation.

2 Materials and methodology

For comparative study to see inconsistent sEMG signals for identical finger gesture, reference [4] is selected. Therein, ten Chinese finger gestures for natural number from zero to nine. Ten Chinese finger gestures as illustrated in Fig. 1. With this, sEMG signals are measured and recorded for each Chinese natural numbers and compared to the results in reference paper [5].

Fig. 1. Illustration of the Chinese number gestures signifying the natural numbers zero through nine [1]

2.1 Surface EMG system

Surface electromyograph (sEMG) used in this work is ActiVIl system of Biosemi. This system has 24-bit high resolution Analog-to-digital device. In ActiveII system, differential sEMG signals at each channel between two electrodes on the measuring muscle are acquired by subtracting from sEMG signal at the one electrode to that at the other electrode.

2.2 Experiment

2.2.1 Electrode placement

To measure sEMG signal at forearm when ten finger gestures are made, sEMG signal on four muscles are measured through the sEMG system. Those selected muscles are extensor pollicis brevis, extensor digitorum, flexor digitorum profundus for little finger and flexor digitorum superficialis. The electrode placements are depicted in Fig. 2. The electrode placements are depicted in Fig. 2.

2.2.2 Experimental protocol

To collect sEMG signals for comparison study, sampling frequency was set to be 1024Hz and bandpass filtered from 10Hz to 450 Hz. To acquire sEMG signals in high accuracy, active electrode is used in ActiveII system.
2.3 Results

sEMG signals measured in this study are depicted in Fig. 3(a). For convenience purpose, the 4-channel sEMG is depicted in Fig. 3(b) [5]. Therein, it can be observed that overall pattern of sEMG signals for most finger gestures are similar with degree of tolerance but pattern of sEMG signals for finger gesture of zero, one, and seven are quite different. This is because degree of muscle activation made difference even in identical finger gesture.

Fig. 3. An example of 4-channel sEMG signals corresponding to Chinese number gestures

3 Conclusions

Surface electromyograph (sEMG) has been one of the active recognition tools for finger gesture recognition. However, as the result in this work shows, sEMG signal could be different depending on how strongly the related muscles are activated even for identical gesture of the number to be recognized. This cause sEMG signals inconsistent to provide wrong feature, thus resulting in wrong classification. Therefore, it is important to set up the protocol for muscle activation of individual finger gesture corresponding to a number to be recognized. Thus, this work highlight further research to get consistent features for sEMG based finger gesture recognition.

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5 References


