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The center of myoelectric signals as a feature to discriminate grasps

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***Abstract*— This paper proposes a visible feature to capture the hand motion from the information of myoelectric signals obtained from multiple electrodes. This feature is the center of the myoelectric signals, the average position of multiple muscle electrodes weighted by myoelectric signals. We preliminary conducted a basic experiment to confirm the center of myoelectric signals corresponding to hand motions by measuring the EMG signals from the electrodes attached around a cross-section of the forearm and confirmed that this feature could visually separate wrist motions and grasps.**

I. Introduction

Surface electromyogram (EMG) is a powerful tool for extracting an intention to control powered prosthetic hands. Typically, we attach muscle electrodes to the skin around neuromuscular junctions of selected muscles. Then, we estimate motions accurately from the myoelectric signals and the information of anatomical musculoskeletal structure. However, it is generally difficult to estimate the intention accurately due to the complex arraignment of muscles relative to joint placement. Recently, machine learning methods have been proposed to estimate motion by the information obtained from multi-point muscle electrodes.

This study proposes a method to capture motion from the positional information obtained from the muscle electrodes uniformly placed around the forearm. We assume that a single virtual muscle source, called the center of the myoelectric signals (CMS), exists corresponding to a movement. We preliminary investigate whether the CMSs can visually classify hand gestures and wrist motions.

II. METHODS

In this method, three healthy subjects took a palm-down position and attached eight muscle electrodes around the forearm near the elbow joint, as shown in Figure 1.

To estimate the position of the electrodes, we modeled the shape of a forearm as an ellipsoid and assumed to place them at equal intervals. We measured the CMSs when the subjects took four different wrist motions (palm flexion, dorsiflexion, flexion, and ulnar flexion) and three different grasps(precision grasp, lateral grasp, and power grasp) five times. The measured myoelectric signals were integrated and normalized by maximum voluntary contraction to calculate the CMSs.

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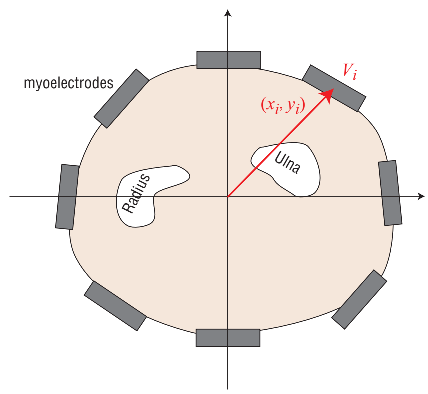

Fig. 1. The arrignment of electrodes.

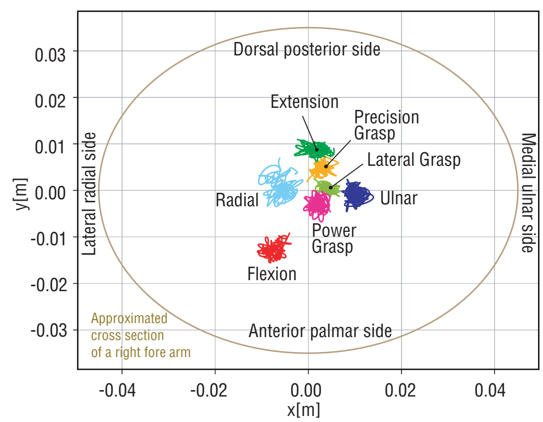

Fig. 2. The center of myoelectric signals for grasps and wrist motions.

III. RESULT AND DISCUSSION

Figure 2 showed the CMSs when a subject performed the above seven movements. The CMSs in the four wrist motions were clearly separated from each other. The axis connected between flexion and extension was tilted, which would be due to the influence of the origin of flexor and extensor muscles. The variation of the radial deviation was larger than the others because the wrist motion in the radial direction was more difficult to move anatomically than the other three directions.

Precision, lateral, and power grasps were adjacent vertically from top to bottom without almost no overlap, inside a region surrounded by the four wrist motions. The variation of CMSs in the power grasp was larger than those of the other grasps because the grasp generated a gripping force larger than the others do.

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