Proceedings of the IEOM International Conference on Smart Mobility and Vehicle Electrification
Detroit, Michigan, USA, October 10-12, 2023

EMG Signal Classification Research to Improve Electric Prosthetic Hand Control Method

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Abstract

In this study, the classification of electromyography signals for use as a method for effective control of the hand of a folding mechanism developed for people with wrist amputations who need prosthetic arms was studied.
For the classification of EMG signals, it consisted of a 4-channel EMG detector, amplifier, filter, A/D conversion, monitoring system, and analysis system.
The system for EMG analysis used in this study consisted of four channels, allowing four muscles to accept and monitor EMG signals.
It can be used as an effective signal to control artificial limbs by measuring electromyography signals in each channel in six movements, measuring signals in four muscles for each movement, and classifying signals, and it is expected that a control method that can be used to control various movements as well as the artificial limbs that have implemented one degree of freedom so far can be implemented.

Keywords

Electric prosthesis, control method, electromyography, classification of signals and EMG

1. Introduction

Recently, there have been many cases in which body members lose their lives due to various disasters and other diseases. These accidents cause difficulties in leading daily life and act as limited activities in social life. However, there are many attempts to improve the quality of life of patients who have lost limbs due to the development of science and technology, and research on the use of external energy sources to control surface myocardial infarction signals and artificial hydrogen is actively being conducted. It will be more natural and convenient if the disabled can control the assistive device and allow a normal person to control the external device by relaxing and moving the muscles. However, in the age of auxiliary devices that replace simple functions, new myopia control methods suitable for multifunctional auxiliary devices are now needed, making it more diverse and easy to operate and control. Modern Electrical Signal (EMG)

In this paper, the goal is to investigate and present various myocardial control methods suitable for multifunctional control, along with the development of mechanical prosthetics with folding structures instead of arm functions.
Research has been conducted in two directions. The first study focused on the design and composition of an analysis system to obtain myocardial infarction for labor force control, and the second study aimed at classifying EMG signals to differentiate each action in practical terms.

2. Body

The hardware components of the measuring system were divided into two parts: the power supply and the sensorics with ag/agel surface electrodes, the reinforcement and the conversion of AlD.

The electromagnetic signal is measured over four channels. In six operations, myelocyte preferences were converted into electrical signals.

Electrodes for recording muscle tone signals have different shapes and structures. The electrodes are initially harmless to the human body and must come in good contact with the muscles to detect the electricity generated by ion movements in the muscles. And the area of electrodes that have electrical contact with the muscle tissue is called the detection surface, whose size is important for recording and analyzing muscle tone signals. For smaller detection areas, muscle activity could be measured in narrow areas, for larger detection areas, overlapping signals of muscle activity in larger areas. Depending on the function, the electrode can be inserted into a recording electrode, a stimulation electrode and a ground electrode. A recording electrode is an electrode used to measure muscle activity, and a stimulation electrode is an electrode that records, unlike a recording electrode. To watch the reaction to a stimulation. And the earth electrode is an electrode used to define the reference potential of a recording electrode that is usually attached to a skin without muscle activity.

The mass electrode that measures muscle activity at a point as a reference potential is called a unipolar electrode. However, in the case of unipolar electrodes, anode electrodes are used mainly because they exhibit properties that are susceptible to electrical noise.

Depending on the shape of the electrode, the electrode that is measured in contact with the skin is called a surface electrode, and the needle-shaped electrode that is introduced directly into the muscle fibers, The surface electrode and the sediment electrode are used separately depending on the measurement area or measurement purpose, with the sediment electrode having the advantage of having a good resolution. The surface electrode, of course, has the disadvantage that it cannot be measured as an electrode that measures the signal in contact with the skin by activating the deep muscles. However, research to supplement these restrictive properties by using surface electrodes in several channels is active and shows much progress.

The 13L05200 disposable surface electrodes used in this study by Medtronic and the electrodes also contain a differential amplifier with a 14-fold advantage, which has excellent sound properties. The output of the electrode was used as input to the company's 110-12V amplifier. The output signals from the amplifiers were recorded with a computer that was scanned at 1400 Hz over a 1500-Aid converter of Nl with an 18-bit resolution and interacted with parallel.

The amplifier works with der14V and consists of a high-pass filter with 20 Hz and a low-pass filter with 3.5 kHz and an emergency filter with 60 to 70 Hz to eliminate the power failure.

The final processed value has been set to be output within this range, taking into account the input voltage range of the AID converter from 0V to 6V. Figure 1 is a circuit diagram used to process analog signals.

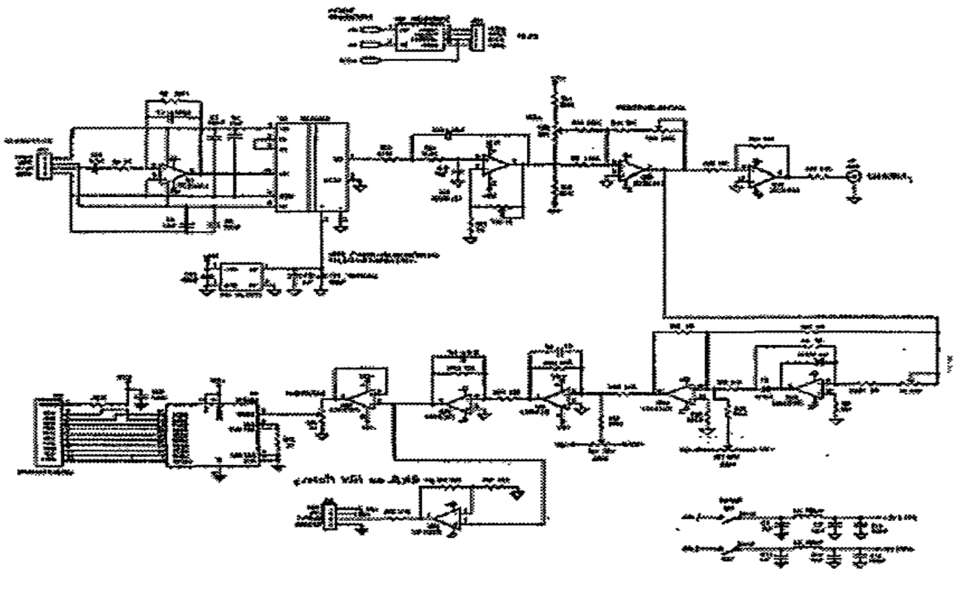


Figure 1. Analog signal processing circuit.

The digital signal processing department used in this study uses the pd-1550 of Nl. This converter has a maximum resolution of 4096 BPS with an 18-bit resolution. The input voltage range is between 0 and 6 volts. The conversion time of 18 bits is 10.5 18s, and the AlD conversion can be set in single-end mode with 8 channels and in differential mode with 4 channels. The data that finished the AlD conversion creates an 18-bit frame and is transmitted to the PC via parallel bus.

In this study, LabVIEW became 8.2 used by the National Instruments Company to analyze signals and displays on PCs. The number of samples was set to 1100 and the number of samples was set to 1100, the limits were not set separately. Figure 2 shows the PC-controlled screen.

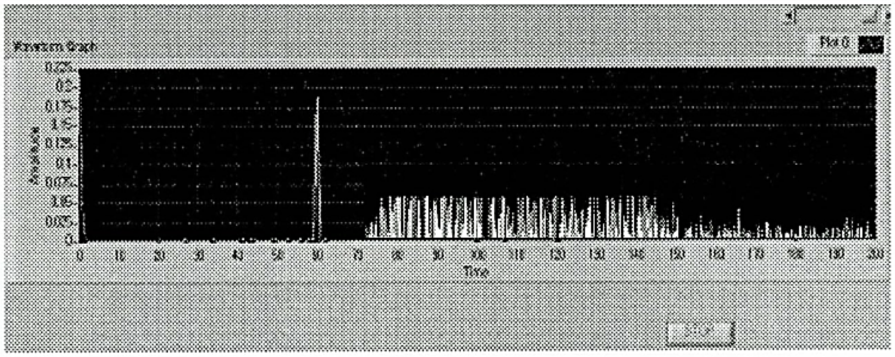


Figure 2. PC action screen

In the basic experiment, an electromyogram (EMG) signal was measured in an ordinary subject in order to confirm whether the EMG measuring system used was working properly and verify the reliability of the system.

The evaluation of the system evaluates the overall function of the system, including ease of use, signal detection capability and the reliability of detected signals.

First of all, an experiment was conducted to measure the electromyogram waveform of a total of two muscles, one flexor and one extensor, using differential mode, and to see if movement can be distinguished.

In the experiment, the most representative Flexor Carpiradialis and Extensors of Forearm, Flexor Carpiradialis, and Extensor Carpiradialis were attached, and six actions (Addition, Abduction, Flexion, Extension, Grasp and Open) were performed to confirm that EMG signals were detected normally.

In order to distinguish the obtained Raw EMG signal easily, Fast Fourier Transform (FFT) was implemented to obtain the frequency component characteristics of the signal, and Power Spectral Density (PSD) and Root Meam Square (RMS) waveforms were obtained.

As a result of the experiment, the distinction between grasp and open among the six movements can be distinguished only by the EMG signal of the 1 channel, but it is difficult to distinguish all six movements that were originally intended. In addition, the experiment confirmed that the pattern classification of electromyographic signals in the electric prosthetic hand control method to improve the folding mechanism can be sufficiently controlled only by 1Channel EMG used in the basic experiment.

Figure 3 shows the shape of FFT, PSD and RMS waveforms obtained by signal processing of EMG and EMG of each action.

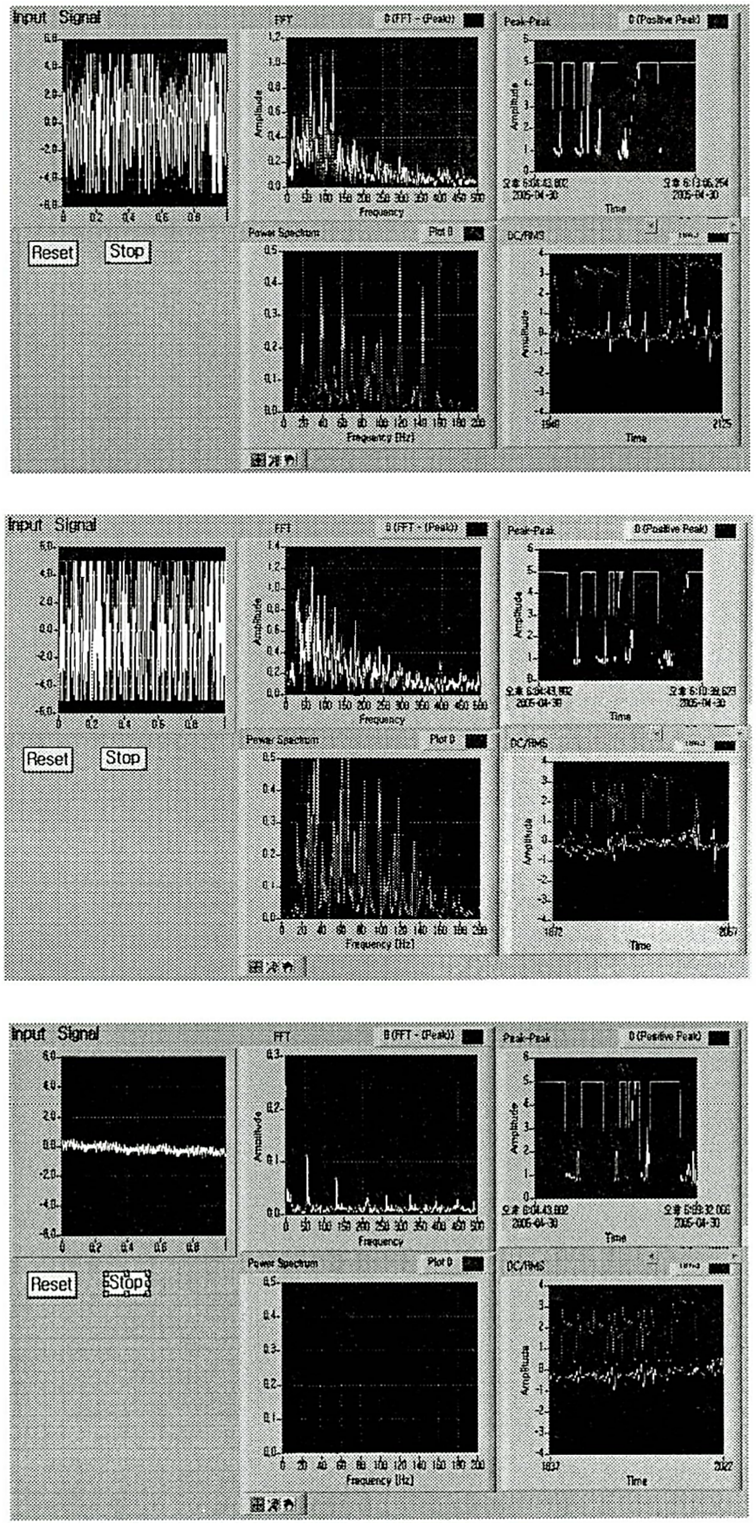


Figure 3. Electromyography and Signal Processed

On the basis of basic experiment, the electromyogram of 4 muscles of Extensor diilitorum, Extensor caroiulnaris, Fexor caroiulnalis and Flexor caroiulnaris were measured. The reproducibility of signals measured by the electromyogram measurement system was studied 10 times for each of the six previously defined actions, and the electromyogram measurement experiment was conducted to obtain data that can be analyzed by various physical interpretation methods.

In order to obtain signals from the same muscle, four sensors were attached to each muscle, and the difference in signals from the reference Brachialis was determined by anodic electrode method with strong noise characteristics.
In order to judge movement, it is necessary to set the appropriate length of the EMG data window and the increase in movement. Electromyogram was measured at 1200Hz sampling frequency after 8~660Hz band-limited pretreatment. The Windows length of the data is 256 msec, and the mobile increase of Windows is 128 msec. There are two main types of data obtained, and the waveform morphological correlation values of each muscle EMG and the waveform size values of 10 stages visible in hardware in the amplifier are monitored by software. Figure 4 shows the motions of muscles located in the forearm

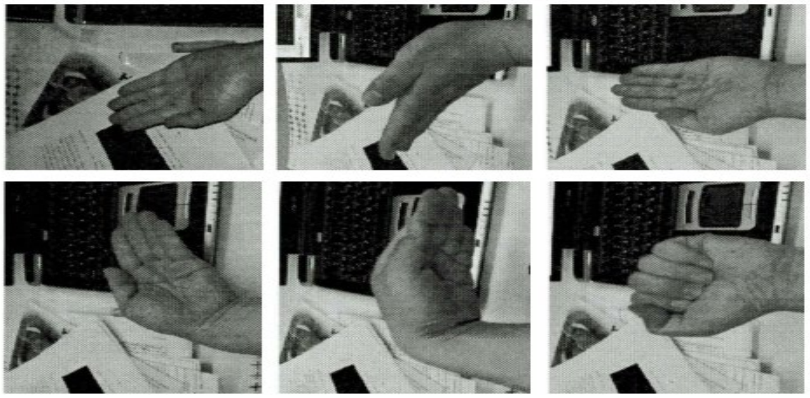
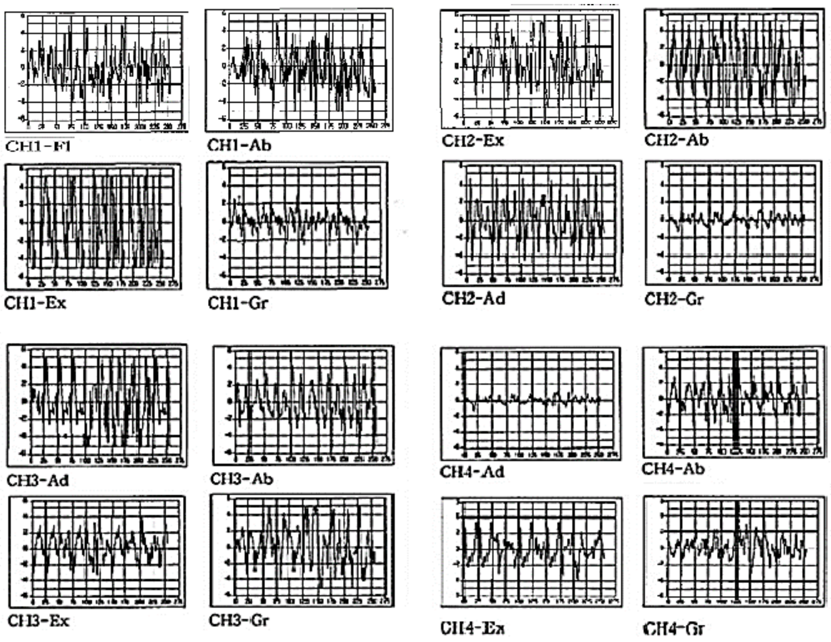


Figure 4. Muscle movements located in the forearm

In the electromyography measurement system used in this study, four Measure electromyography signals from each muscle and sample at a sampling rate of 256msec. The amplitude of the waveform during this period is shown in Figure 5.



CH1-Fl CH1-Ab CH2-Ex CH2-Ab
CH1-Ex CH1-Gr CH2-Ad CH2-Gr
CH3-Ad CH3-Ab CH4-Ad CH4-Ab
CH3-Ex CH3-Gr CH4-Ex CH4-Gr

Figure 5. Electromyogram waveforms in multiple motion-specific muscles

In addition, the obtained EMG waveforms were classified in three ways in addition to visual comparison using various physical interpretation methods. First of all, in the experiment, the integration value and RMS value of each EMG signal are compared in the second time zone by using the hardware-supported LED bar, and PSD value for feature comparison is found in the third frequency zone.

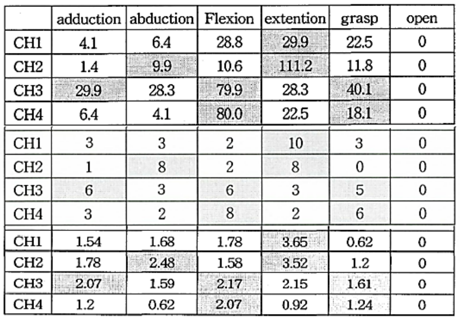
The PSD waveforms used to compare the integral values, RMS values, and specific comparisons in the frequency region of EMG signals in the time region.

In AD Converter, which is included in the electromyographic signal hardware size classification amplifier using LED bar, the size of each action signal can be distinguished by using LED bar in 10 stages according to the size of the electromyographic signal.

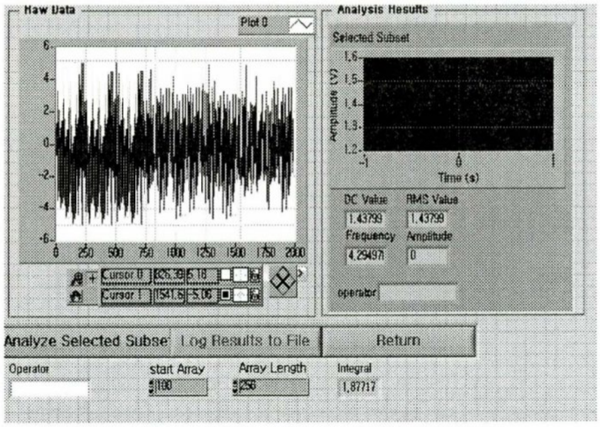
Table 1 shows the magnitude of the EMG waveform after numericalization.

Considering the EMG waveform of each channel, if the waveform size exceeds five out of ten stages, it indicates that there is a waveform, and each channel can be distinguished by operation through the color division unit. Figure 6 shows the analysis of electromyogram signals.

Table 1. Numericalized EMG waveform size values.



	adduction	abduction	Flexion	extention	grasp	open
CH1	4.1	6.4	28.8	29.9	22.5	0
CH2	1.4	9.9	10.6	111.2	11.8	0
CH3	29.9	28.3	79.9	28.3	40.1	0
CH4	6.4	4.1	80.0	22.5	18.1	0
CH1	3	3	2	10	3	0
CH2	1	8	2	8	0	0
CH3	6	3	6	3	5	0
CH4	3	2	8	2	6	0
CH1	1.54	1.68	1.78	3.65	0.62	0
CH2	1.78	2.48	1.58	3.52	1.2	0
CH3	2.07	1.59	2.17	2.15	1.61	0
CH4	1.2	0.62	2.07	0.92	1.24	0



Cursor 0 825.39 5.18
Cursor 1 1541.6 -5.06

DC Value 1.43799
RMS Value 1.43799
Frequency 4.29497
Amplitude 0
operator

Operator
start Array 100
Array Length 256
Integral 1,87717

Figure 6. EMG Signal Analysis Screen

3. Conclusion

This paper studies the classification of electromyographic signals as an effective method to control the folding mechanism prosthetic limbs developed for the wrist amputation disabled.

The system used in this study for EMG analysis allows the reception and monitoring of EMG signals from four muscles.

Electromyogram signals were measured for each channel during six operations.

For each movement, signals in four muscles can be measured and classified as effective signals for controlling prosthetics, and a control method is expected to be implemented not only for controlling prosthetics that achieve the current degree of freedom, but also for various operations.

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Biographies

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