# A METHOD FOR PROCESSING BIOLOGICAL SIGNALS OF THE MUSCLE TO CONTROL A BIOMECHANICAL PROSTHESIS

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The question of managing electromechanical prostheses remains open in the world. In many countries, in the largest scientific and technical centers, similar problems are solved, that is, models of hands are created that perform a wide variety of actions (MIT, The University of Southampton). These studies are aimed at ensuring that the control system allows patients to use upper limb prostheses with greater convenience and efficiency [1].

The aim of the study is to study the control of a biomechanical hand prosthesis using electromyography technology, which could perform the basic movements inherent in the human hand.

In our study, it is proposed that the management of a biomechanical hand prosthesis using electromyography (EMG) technology (see fig. 1.) is considered. Variants of the implementation of control methods are due to the fact that prosthetists and developers may face various problems of an elemental and software nature (lack of the required number sensors, too long signal processing time and others) [2]. The method is implemented by placing three electrodes on three muscle groups responsible for setting the hand in motion.

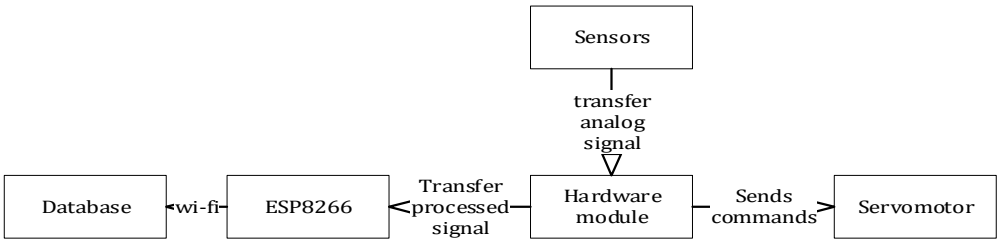



Figure 1 – Scheme of reading and processing a signal from the hand

The essence of biomechanical prosthesis control is to detect the muscle contraction responsible for the movement of the group above the threshold value, which makes it possible to cut off accidental muscle contractions or equipment interference and regulate the degree of finger compression in accordance with the duration and amplitude of the signal.

There are three conditioned signals that the patient sends by contraction of the muscle group and the system understands that the hand should be folded in a certain gesture [3].

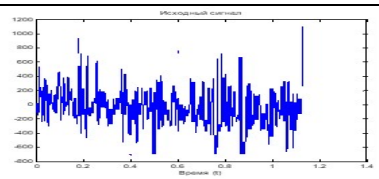
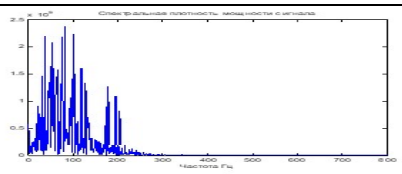
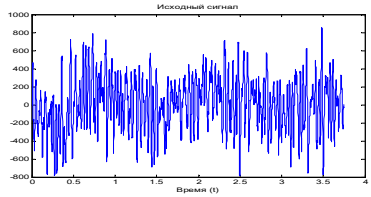
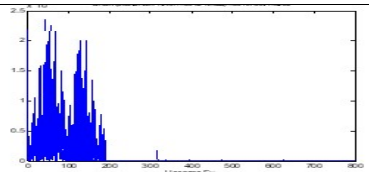
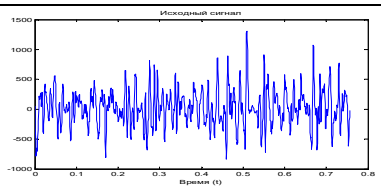
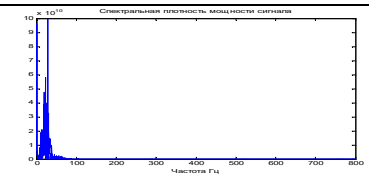
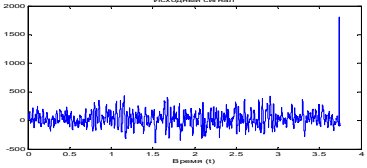
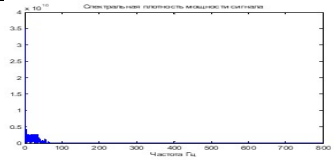
Similar signals coming repeatedly or from the antagonist muscle indicate to the system that it is necessary to return to the initial position. Three electrodes are located near the elbow joint and, using a signal processing algorithm based on a neural network, allows one to interpret certain muscle contractions in certain hand movements.

Prosthesis operation algorithm:

1. Analog signal reception function.
2. Access to external sensors.
3. Capture the flow of bioelectric signals.
4. Save the signal to the chip.
5. Signal filtering function.
6. Receiving a signal.
7. Signal filtering from noise.
8. Conversion of the signal to a two-dimensional array.
9. The function of comparing the signal with certain movements.
10. Comparison of signals with those embedded in the microcontroller.
11. Select the most similar movement.
12. Making motion in the motion variable.
13. Output the result to the user.
14. Enable General Purpose Input Output to which the boards are connected.
15. Output of the result to servomotors based on data from variable motion.

Table 1

Initial signals and their processed versions.

| Class name | Initial signal | Signal spectrum | Parameters |
|---|---|---|---|
| X1 |  |  | $X$=26.000<br>$M_0$=25.000<br>$D$=38.582<br>$\sigma$=24.682 |
| X2 |  |  | $X$=32.000<br>$M_0$=30.000<br>$D$=38.255<br>$\sigma$=13.523 |
| X3 |  |  | $X$=37.000<br>$M_0$=32.000<br>$D$=45.548<br>$\sigma$=*21*.039 |
| X4 |  |  | $X$=18.000<br>$M_0$=17.000<br>$D$=34.591<br>$\sigma$= 15.071 |

*X1-X3 – wrist movement, X4 -- calm sate.

The signal from the muscles itself was processed and cleared of noise using these indicators of biopotentials for different muscle groups [3].

As a result of an experiment, data was obtained that was used to build a template and train the system to recognize certain hand actions. (see tab. 1)

The proposed control method allows to solve the complex problem of controlling the biomechanical prosthesis of the hand, set the vector for further research, and also allow to form a methodological basis for research and further development in this area. In addition, the developed algorithms to some extent allows restoration of the lost functionality to the patient, and allows him not only to serve himself, but also to fully perform professional functions. In addition, the developed of the algorithm to some extent and additional development of the hardware of prosthesis will allow to restore the lost functionality to the patient, and will allow them not only to serve himself, but also to fully perform professional functions.

## References

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3. Castellini, C., Gruppioni, E., Davalli, A., and Sandini, G. (2009). Fine detection of grasp force and posture by amputees via surface electromyography. J.Physiol. (Paris) 103, 255–262. doi:10.1016/j.jphysparis.2009.08.008

## Аннотация

Рассмотрена проблема управления современных биомеханических протезов. Предложена схема считывание и обработки сигнала с руки а также представлена схема алгоритма работы протеза. Были представлены данные четырех шаблонных сигналов.

Ключевые слова: протез, электромиография, сигнал, биомеханинка.

## Abstract

The problem of management of modern biomechanical prostheses is considered. The scheme of reading and processing of a signal from a hand is offered and also the scheme of algorithm of work of a prosthesis is presented. Data from four template signals were presented.

Key words: prosthesis, electromyography, biomechanics.

## Анотація

Розглянуто проблему управління сучасних біомеханічних протезів. Запропоновано схему зчитування і обробки сигналу з руки а також представлена схема алгоритму роботи протеза. Були представлені дані чотирьох шаблонних сигналів.

Ключові слова: протез, електроміографія, сигнал, біомеханіка.