

THE NEUROPHYSIOLOGY OF PROSTHETIC CONTROL

Kotsuba N.A., student
Scientific supervisor – Lichevskaya S.P., senior lecturer
English language department №1
Belarusian National University of Technology
Minsk, Republic of Belarus

Amputation means removing a body part, such as a limb, resulting in a person losing mobility and the ability to perform many habitual actions. These changes have a huge impact not only on the physical but also on the emotional state.

The reasons for the loss of a limb can be varied, among them the most common are severe injuries, vascular diseases and oncology. However, in recent years, due to the development of technology, neuroprosthetics has become an important and popular topic.

Modern prostheses, which have high functionality and convenience, provide people with new opportunities to improve their quality of life. These devices can significantly improve everyday existence, returning people the opportunity to live a full life.

Currently, humanity has gone through 4 generations of prosthetics. The latest of them, “the 5th generation, SM neuroprostheses are the most advanced prostheses that allow you to restore motor functions through direct interaction with the human nervous system.

To restore lost motor function, SM neuroprostheses measure the electrical activity of the residual motor nerves in the stump of the amputated limb and convert it using decoding algorithms into a command signal that controls the electric motors of the prosthesis.

To restore the lost function, SM neuroprostheses simultaneously and independently transmit electrical signals from pressure sensors located in the prosthesis and convert them using sensory coding algorithms into electrical impulses with different amplitudes and frequencies” [1].

One of the main advantages of SM prosthetics is not only the accuracy and ease of control of the prosthesis, but also improved aesthetics, which makes these devices more convenient to use and visually attractive.

However, this type of neuroprosthetics also has its drawbacks. They require regular calibration of sensory and motor algorithms to maintain their correct functionality. These prostheses can also be quite expensive to maintain and repair, which is an important factor when using them [1].

One of the most outstanding achievements in the field of upper limb prosthetics is the Luke Arm, developed by Mobius Bionics (USA).

This prosthesis, which has several degrees of freedom, is the result of 15 years of intensive research and development. The peculiarity of the device is the use of peripheral nerve stimulation technology, which allows to significantly increase the functionality of the prosthesis.

Electrodes installed on the nerves of the arm above the level of amputation and on the prosthesis itself provide effective interaction with the nervous system, creating a control system that is closely linked to the neural activity of the user.

Controlling such a prosthesis requires some training, since neural signals can vary significantly among different people. However, thanks to constant software training, the device eventually adapts to the user's individual signals, restoring lost motor abilities [2].

Despite many years of research, full integration of the prosthesis with the user's body remains one of the main unsolved problems in neuroprosthetics.

At the moment, the key direction in this area is the creation of effective coordination between the prosthesis and the body, which requires minimizing time delays between sensory and motor processes.

SM prostheses are aimed at improving sensory feedback, as well as reducing the time between decoding movements and encoding sensations.

The use of new technologies and innovative solutions promises to significantly improve these processes, which in turn will increase the level of comfort and quality of life of people who have faced limb loss.

References

1. Elbasiouny, S.M. The neurophysiology of sensorimotor prosthetic control. BMC biomed eng 6, 9 (2024). – URL: <https://doi.org/10.1186/s42490-024-00084-y> (date of access 10.03.2025).

2. Экспертный обзор «Технологии ассистивной биомехатроники» / Е. И. Аксенова, Н. Н. Камынина, С. Ю. Горбатов – М.: ГБУ «НИИОЗММ ДЗМ», 2020. – 28 с.