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NEUROENGINEERING: PERSPECTIVES OF NEUROPROSTHESES AND NEUROIMPLANTS

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Annotation. A study was made of the development of prosthetics from the earliest models to the latest. It is considered in the article how the work of the latest models of neuroprostheses is carried out. Proposed possible innovations in the field of neuroengineering in the near future. Considered non-standard possibilities of using neuroprostheses.

Keywords: neuroengineering, neuroprostheses, neuroimplants

Introduction. In our time, it is often possible to find cases when a person receives injuries that don't let him live a full life. Loss of limbs, damage to the brain or spinal cord, which limit the capabilities of a person and cause a lot of problems. To solve these problems, limb substitutes and devices that are implanted in a person and perform a specific function were invented.

The main part. Neuroengineering is a scientific direction as a part of biomedical engineering, which uses engineering methods to study, restore the nervous system. In this paper, we will consider two specific examples from this area: neuroprostheses and neuroimplants.

Firstly, let's look at what people were doing at a time when technologists were not so advanced yet. Wars in ancient Greece did not spare soldiers: about 80% of the wounded died on the day of the battle, and of the remaining 20%, every third died from their injuries. Of course, replacing lost limbs became one of the most important tasks of medicine. In ancient Greece, amputation began to be used at the end of the V – the beginning of the IV century BC. Around the same time, orthopedic surgery began to develop, and the ancient Greeks had the first prostheses, which became an alternative to crutches and sticks for support.

The ancient Egyptians used a similar technology. Archaeologists managed to find artificial toes made of wood in the tombs. As the researchers say, signs of wear and tear demonstrate their vital necessity, and not an aesthetic function. Presumably, they were intended to increase the area of support when walking [1].

Now let's consider what level the technology has reached in this field at the moment. As examples, consider Germany and China. So, Germany. One of the most famous companies for the development of neuroprostheses is the Ottobock concern. One of the developments of this concern is the C-Leg 4, Genium and Meridium prosthetic systems. A representative of a new generation of bionic lower limb prostheses that adapt to the individual characteristics of the gait of their owner. Allows you to walk freely and safely on stairs, rough terrain, loose, hard, heterogeneous coatings instantly stop or start moving. This is all possible thanks to a four-axis design and software that is controlled by artificial intelligence. Aluminum and titanium are used as materials [2].

China is also one of the centers for the development of neuroengineering. At the moment, there are already models that repeat not only the structure of the arm or leg, but also their functions, such as tactile sensations, but at the same time these models are very expensive and have more weight than a real hand. In China, they have already created a prototype of the neuroprosthesis of the hand, which has a great advantage compared to other models.

The prosthesis is made of a soft, elastic material and consists of five finger-balloons, each of which is covered inside with segments of plastic, similar to the articulated bones in real fingers. Bending fingers are attached to the "palm" in the form of a human hand. At the same time, instead of the motors that control the fingers in other models, the prosthesis uses a pneumatic system to precisely inflate the fingers and bend them in certain positions [3].

How do these devices work? Consider this on the example of the Chinese prosthetic arm. As it was mentioned earlier, in this technology is used a pneumatic system of pumps. The developed computer model correlates the desired position of the finger with the pressure that the pump must provide for the finger to take the desired position. With this model, the controller controls a pneumatic system to inflate the fingers in positions that simulate general grips. The pneumatic system receives signals from electromyographic sensors installed in the residual part of the limb. The sensors measure the electrical signals generated by the muscle's motor neurons when a person with an amputated limb thinks about how they would move the brush – for example, clenching a fist, the controller translates these signals into the amounts of air pressure in the artificial fingers. The pump pumps air into the fingers under the right pressure, and the fingers grasp the object. Sensors are installed in the holes of the prosthesis, at the place of its attachment to the user's limb. Also, engineers attached pressure sensors to the tips of all fingers, which, when touching any surface or compressing an object, give an electrical signal proportional to the perceived pressure. Each such sensor is connected to a specific location on the residual part of the limb of the prosthesis user. Due to this, a person can feel when the thumb of the prosthesis is pressed, for example, to the index finger [3].

Absolutely everything in this world is developing, so what awaits us in the future? At the moment, not only new, more functional models of prostheses are being developed, but also neuroimplants that are implanted in the human body. More specifically, there is a development of an implant that will be implanted in the brain and work on the principle of a computing center, which will increase the performance of the brain. And, the development of implants that will replace parts of the nervous system. There are already successful models with which a person with paralyzed legs was able to walk, but, unfortunately, they are very expensive and are not suitable for all people since it is necessary to adjust them to the characteristics of a particular part of the nervous system and a particular person.

Conclusion. Someone will think, why do we need developments in this area? Maybe it's better to develop areas where they study ways to restore lost limbs and grow new organs? They may be right, but let's look at neuroprosthetics technology from a different side.

Yes, neuroprostheses are one of the ways to replace a lost limb, but what happens if you expand its functionality? In this case, the prosthesis will become not only a part of your body, but also a very useful device. After all, in theory, who prevents you from embedding a mini computer there, or a means of communication, or using different nozzles for different professions? That is, if neuroprostheses get a more diverse functionality, then not only people without limbs, but also ordinary people will want to install them, because it is not only strengthening the body, but also new opportunities. The same neuroimplants that will allow you to better control your body and make your brain work at higher capacities. Maybe the future, where cyborgs make up the majority of the population, is not so fantastic?

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