CREATION OF BIONIC PROSTHESES ON THE 3D MODEL OF THE LIMBS, ALLOWING TO SIMULATE IMPORTANT PHYSIOLOGICAL FUNCTIONS

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3D printing, or additive manufacturing, is a technology that uses a digital model to print a three-dimensional object, layer by layer. Today, it is widely used in many different fields and provides a manufacturing method with advantages such as precision and the ability to print complex shapes from many different materials. 3D printed prostheses have recently gained a lot of interest thanks to the possibility to reduce material costs and production time. The aim of this thesis has been to create a body-powered 3D printed prosthetic arm and evaluate the 3D printing technology for this purpose. The final prototype is lightweight, easily maneuvered for the user and with a simplistic design. However, many aspects still require future work to develop a fully functional prosthetic device, which is discussed at the end . The project has shown that 3D printing is an incredible method with potential to make prostheses more customized, cheaper and produced faster. Hopefully, this area will continue to grow to help more patients.

However, looking at the usage of prosthetics from a bigger picture, there is an unequal distribution throughout the world. Many prosthetic devices are highly developed with expensive technical features, though not available for everyone. Especially in developing countries, there is a high demand for cheap and easily manufactured artificial limbs, which is why these solutions are just as important. This is also true for amputated children all over the world who are growing rapidly and need to update their prosthetic devices at a fast rate, resulting in an expensive and often time-consuming process.

Definition and Purpose

Bionics is an applied science that combines biology and technology. Wildlife helps a scientist find solutions for technical devices. There is a biological system that studies the processes in biological systems. Technical bionics is important to us now: it uses models of theoretical bionics to solve engineering problems, as is the case with prostheses. Previously, experts meant by "bionic" prostheses such devices that they replace. From this point of view, modern concepts are prostheses that control electronics and biocurrents, that is, they use myography or encephalogram. The British company RSLSteeper, which currently has about 90 years of experience in prosthetics, is Be-Bionics' white-bionic hand prosthesis on the international market in 2010. We have only four functional captures in which it is possible to drink, type, turn the key in the lock, use an ATM and hold small items. This can be both strength and strength, which is regulated by the team. The lack of mass demand and low competition is the main reason why bionic prostheses are

very expensive. In 2013, a prosthetic palm cost up to one hundred thousand dollars. In 2013, the IndieGoGo crowdfunding campaign was successfully completed to create an open and accessible palm prosthesis, most of the details for which can be printed on a 3D printer. The device has independent drives for each finger, tactile feedback and reads signals through the skin to control.

The aim of the project is to create a body-powered and 3D printed prosthetic arm and evaluate the 3D printing technology for this purpose. The goal is to design a simple, yet functional transracial prosthesis, i.e. a prosthesis starting below the elbow. An existing method for custom made sockets based on 3D scanning will be used. The ambition is to combine the comfort of a personalized socket with a 3D printed hand and arm that can easily be maneuvered by the user.

Based on international experience, design a bionic prosthetic arm and identify installation options and the ability to equip tactile-sensitive sensors that will create favorable conditions for a fully human life and not have allergic reactions to health, taking into account the physiological characteristics of the person.

The relevance of the project:

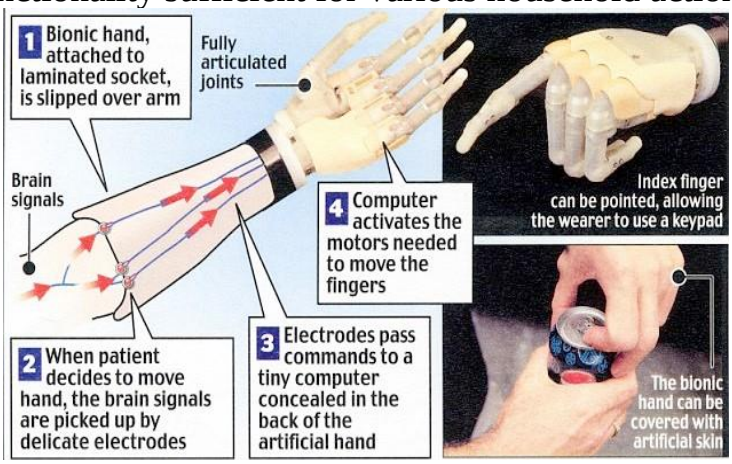
Losing any limb or any organ for a person is a big problem. In some cases, it has to be tolerated, but sometimes modern prosthetics can make a high-quality, comfortable, reliable and affordable prosthesis. Modern bionic prostheses have the functionality sufficient for various household actions. But there is one more thing that scientists are working on: the sensitivity of prostheses. It is important for a person’s hand to understand how strongly to squeeze something, what exactly can be taken in hand, which is impossible. So with an artificial brush - it will greatly improve the ability to feel.

According to the central database of persons with disabilities, 12,794 people with amputations of the upper and lower extremities are registered in Kazakhstan. Of these, 840 are children. This is not counting those born with pathologies. Functional prostheses at the expense of the state receive a limited number of people, and most people with no disabilities have no alternative.

Today's silicone casting technology has reached such a level that, with the right color selection, it is impossible to distinguish a prosthesis from a tree limb. The prosthesis can be equipped with sensors with processors and lithium batteries, which will allow the client to perform any physical exercise when replacing a limb with a high-tech prosthesis. First, the patient is scanned intact part of the body with a resolution of 0.1-0.01mm. A 3D image is entered into a computer, on the basis of which, with the highest repetition accuracy, a solid prosthesis will be manufactured on the CNC machine or a mold for casting a silicone prosthesis with the desired color. And then the mechanical part of the prosthesis is also manufactured on the CNC machine. Now there are two directions for the development of bionic prostheses:

- The first is the sensation, that is, feedback, which allows the owner of the prosthesis to obtain information about the qualities of the object to which he touches the device.

•The second is the implantation of all elements, including the frame and the sensor. One of the problems with modern prostheses is the need to remove such a prosthesis for sleeping or taking a shower. Modern foreign bionic prostheses have the functionality sufficient for various household actions.



In Kazakhstan, functional prostheses are also assembled using 3D scanning and printing technologies and even develop domestic models.

Bionic prostheses in Russia

In the Russian market, there are virtually no players who have introduced bionic prosthetic hands into commercial use. The development is being carried out by the start-up "Motorika", known for introducing traction prostheses for children into the federal program for providing people with disabilities with technical means - thanks to this company, children receive traction prostheses at the expense of the state. In this video - tests of the fourth prototype of the artificial brush Stradivari, which the team plans to start producing and installing in Russia in October-November 2016.Stradivari prosthesis - myoelectric. To install it does not require surgery. Surface sensor sensors are built into the receiving sleeve, touch certain places on the skin in the area of the muscles, pick up the potential in case of muscle contraction and transmit a signal to open or close the hand. The main problem encountered when installing this type of prosthesis is poorly developed muscles of the forearm. To avoid this problem, "Motorika" also makes traction mechanical prostheses for children - such prostheses not only help to perform various functions of the hand but also serve as a simulator.

The problem is that when it comes to a prosthetic arm, arbitrarily high-tech, usually no one talks about one problem: the lack of a sense of touch, as a result, it is very difficult for a person with such a prosthesis to control the force with which one or another operation is performed. Modern prostheses do not transmit tactile feedback to the patient. The patient cannot, with the help of touch and tactile touch, understand which object is in front of him, and understand what form he is, what his properties are if he does not see it visually. Similar properties of bionic prostheses in our country are not yet considered and foreign analogies in the stages of the study. With the help of such a prosthesis, a person can take a cup in his hand or open a door. And there is no need to cut the hand to connect nerves with the bionic wrist. The prosthesis is equipped with sensors that are attached to the skin.

Each prosthesis must be assembled individually to better suit a particular user. For example, when a person has muscle atrophy, the individual settings of the prosthesis can help him or her manage the prosthesis, even if he or she has already forgotten how to manipulate fingers or wrist. The prostheses, made with impact-resistant plastic, are currently produced on a 3D printer, but he wants to replace certain parts with titanium.

The proposed solution to the problem:

1. Within the framework of the project, before making the sleeve, we scan the patient's leg that will be in contact with the prosthesis and a healthy limb.

2. According to the data obtained from the 3D scanner, our designer creates a virtual case model taking into account all the physiological features of the patient. He is necessarily advised by orthopedic surgeons. Previously, prosthetics had to measure everything manually and make a plaster cast of a stump. 3D-scanner copes with the same task much faster and more accurately.

3. After this, within the framework of the project, other parts of the bionic prosthesis are created in accordance with the project's purpose, and they are assembled as a designer.

4. After collecting the prosthesis, we add an electronic filling and sensors to it.

The feature of our prostheses is that they can tactilely touch objects. That is, they will have tactile functions that will help their owners to quickly master these bionic prostheses and reintegrate into society.

Expected results:

- Selection of materials for manufacturing that do not cause allergic reactions and will not be rejected by the human body;
- The results of studying chemical processes and physiological parameters of a person (in particular, the bioelectric activity of muscles and nerves);
- Creation of mechanics and the trajectory of the bionic prostheses;
- Designing tactile-sensitive bionic prostheses;

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