ORIGINAL RESEARCH ARTICLE   **OPEN ACCESS**

PROBLEMS OF THE BIONIC ARTIFICIAL LIMB'S CREATION OF THE NEW GENERATION

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ABSTRACT

The LLC "Bionic Natali" company is a startup and has been engaging in the creation of bionic artificial limbs of hands for more than 2 years. From the first steps, the project was been directed on the solution of a problem of development of the domestic bionic functional artificial limb of the hand based on neural network and others algorithms. In the project it had been created the functional system of management, system of tactile feedback which has increased controllability of a functional artificial limb is already realized and integrated, and also the functional bionic artificial limb of the hand. Based on this work it had been done the general representations and practical application of machine training, neural network and others algorithms. But most problems are not just in creation of system of control, but also in creation of mechatronics and materials, because all system of hand are very difficult and when there are sensors on them it makes conditions when most materials what could be used before, can't be used now. Exist huge question is - how to make artificial hands more quiet and more close to real hand.

INTRODUCTION

Now, in most cases in the absence of hand artificial limbs, which bear only the cosmetic purposes that, actually, is a manual model without functionality. Electromechanical artificial limbs which allow to replace partially functionality of a full-fledged hand are widespread poorly at present and have limited functionality, and also are available to still limited circle of users. Especially this situation is characteristic of Russia that is explained by influence of several factors: the certain structure of schemes of social insurance causing an order of financing of prosthetics for the state account low consumer ability of the people who have lost a brush and, of course, absence in the market of decisions in various price segments with the significant level of functionality. Within the project of the LLC **"Bionic Natali"** company the hi-tech bionic artificial limb which surpasses all domestic functional electromechanical and cosmetic artificial limbs in the Russian Federation has been developed and also will surpass foreign bionic artificial limbs in functionality by industrial production.

And the LLC "Bionic Natali" company is faced by a task to make him available to most of disabled people due to considerable reduction of cost in comparison with foreign bionic artificial limbs, about by 5-6 times. Also it should be noted about a know-how the project, creation of innovative system of reading on bigger quantity of electrodes, than in the current foreign bionic artificial limbs which is also radio and it is constructed on the principles of neural network and other algorithms. But most problems are not just in creation of system of control, but also in creation of mechatronics and materials, because all system of hand are very difficult and when there are sensors on them it makes conditions when most materials what could be used before, can't be used now. There is a huge question how to make artificial hands more silent and more close to a real hand.

Essence of technical problems

Technical task, realized within works and development was the following:

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- Reliable functional intellectual bionic artificial limb of an extremity with return of tactile communication by means of neuromuscular signals
- Way and control system of the auxiliary device, such as extremity artificial limb.

The main problems, which are been put before LLC "Bionic Natali" at implementation of the project:

1. Increase in accuracy of positioning of engines
2. Increase in accuracy of the obtained data at recognition of gripper
3. Increase in accuracy and probability of recognition of gripper
4. Making decision on capture of a subject and increase in controllability of gripper.

However, there is a list of problems, which remain for later period:

1. Cover of artificial limbs of silicone or other material with sensors on hands
2. How to make the artificial hand more silent
3. How to make the artificial hand more faster
4. How to make the artificial hand more sensitive

The answer to these problems is in huge attention because there are not any decisions yet. The general structure of technical solution is been presented on the figure.
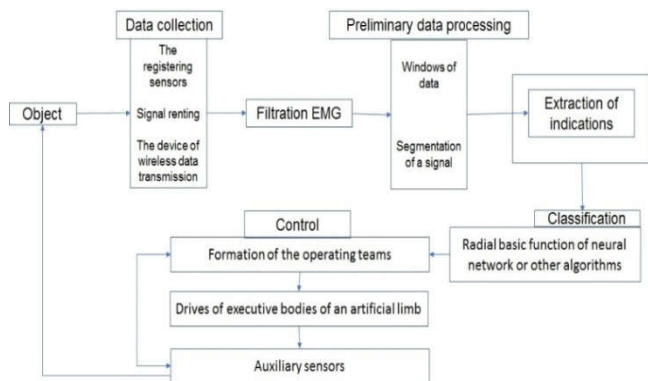

Fig. 1. The general structure of technical solution

Also in a picture, the example of an arrangement of sensors on the hand artificial limb is been shown below.
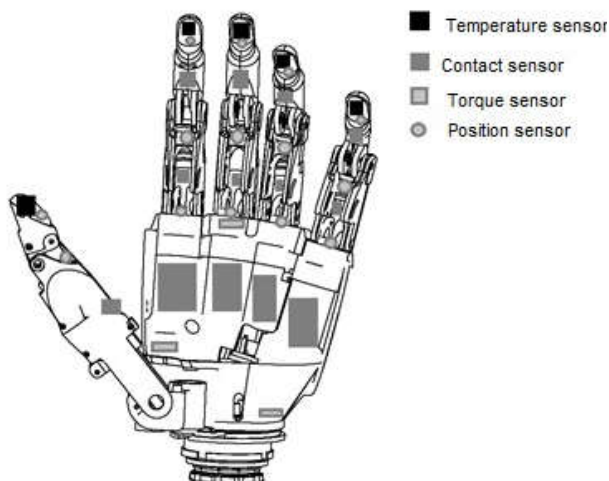

Fig. 2. Example of an arrangement of sensors on the hand artificial limb
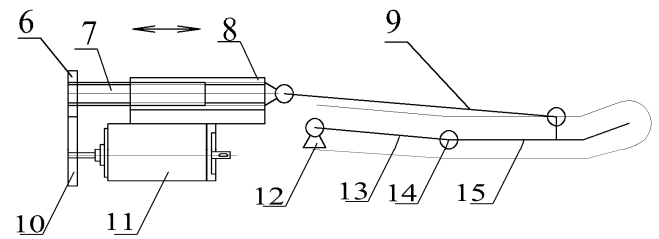

Fig. 3a. Example of the movement of the finger of the hand artificial limb (relax position)
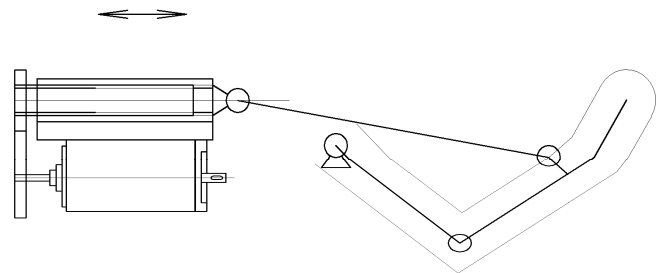

Fig. 3b. Example of the movement of the finger of the hand artificial limb (bent position)

According to the previous researches described in a source of information for a condition of implementation of requirements of work in real time, the time of recognition of a signal has to occupy no more than 250 ms. For comfortable work of the user productivity or recognition accuracy, the percentage of right cases of classification to all considered cases has to be not lower than 95%, as shown in a source (Englehart and Hudgins, 2003). For the purpose of increase in accuracy of classification of gesture and prevention of false operation of a bionic extremity at a stage of preprocessing of a signal, along with calculation of the maximum value of a segment of the EMG-signal, the average duration of excess of threshold value of the EMG-signal in a window of data in real time is calculated. Then, after centering and normalization of the received signal, the decision on generation of the operating signal is been made. As it had been seen on figure 2 and 3a and 3b there are special mechatronics and movements of fingers, what make condition to "covering skin". The usual silicone did not give results for touches and sensitivity, because the thickness of a cover is from 2 mm and the consistence is not uniform, the results sensors on the hand with such skin lose information or send it not correctly, as result it is important to make special touch skin for artificial hands with sensors. In addition, there is a huge point about pleasant appearance - it means that skin on artificial hand must be more close to real skin. It must be pleasant in touch, warm, with nails, small hair and veins. Moreover, what is the most important: everything must be very quiet when person with disabilities uses these artificial hands. The main technology of control had been described in (Ivaniuk *et al.,* 2017) article. Besides, there are huge problems of production of spare parts in Russia because of a small number and difficult forms, but everything is solving "step by step".

Summary

Despite the fact that huge amount of works has been made, there is still big area for activity concerning the choice and improvement of an algorithm on recognition of gripper,

improvement of mechatronics and skin for an artificial hand. Similar work can be compared to art as we will compare the choice of an algorithm, skin and the solution of other technical problems with creativity. In this regard, the decision together with many medical centers to develop a method of restoration of muscles and to create the tool for their training and checking artificial limbs has been made.

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