

Development of Detailed 3D Model of Bioelectric Prosthesis for Proceedings

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Abstract: The goal of the work is to develop a detailed 3D model of bioelectric prosthesis for people with disabilities. On the basis of which it is possible to create a bioelectric prosthesis that differs from similar solutions with minimal labor inputs and will ensure maximum comfort for people deprived of their limbs.

Key words: 3D model, bioelectric prosthesis, Solidworks,

I. INTRODUCTION

The purpose of prosthetics is the return of the invalid to the possibility of self-service and to work. Since it is difficult to artificially reproduce the entire functional of a healthy human hand at the present stage of technical development, the main task is to create a prosthetic device capable of filling as much as possible the lost functions.

II. DEVELOPMENT OF A 3D MODEL OF HAND

Each finger, depicted in Fig. 1, in the developed model of the prosthesis consists of three separate printed components connected together by means of polypropylene pins. The hinges around the fingertips are needed to create a tendon blocking point. These tendons pass through the channels inside the finger, these channels are depicted in Fig. 2, forming a closed loop. When the tendons are stretched, the rotational force is applied to all joints, and the finger is twisted.



Fig. 1 Model index finger in assembly

The tendon fixation point is necessary, so when the tendons are tensed, it pulls the fingertip and causes all joints to rotate. If the tendons did not have the ability to be blocked, it would simply slip in tension and the finger did not move. To open the finger from the closed position, the voltage to the other end of the tendon is applied.



Fig. 2 Model index finger at the intersection

It is recommended to use high-quality wood, as it provides a minimum stretch for tension. The nylon line will stretch over time, which will lead to loss of voltage, which will negatively affect the movement of the fingers. The tendons in the biological human hand work in the same way, but there are many more biological tendons attached to different bones, which allows you to more precisely control your fingers.

The thumb, depicted in Fig. 3, was designed in a similar way. Most commercial and research prosthetic hands are aimed at ensuring at least two degrees of freedom of the thumb. However, this finger provides only one degree of freedom - it can open. The tendon fixing point is necessary, so when the tendons are tensed, it pulls the tip of the finger and causes all joints to rotate. If the tendons did not have the ability to be blocked, it would simply slip in tension and the finger did not move. To open the finger from the closed position, the voltage to the other end of the tendon is applied.

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The thumb, depicted in Fig. 3, was designed in a similar way. Most commercial and research prosthetic hands are aimed at ensuring at least two degrees of freedom of the thumb. However, this finger provides only one degree of freedom - it can only open / close in one way.

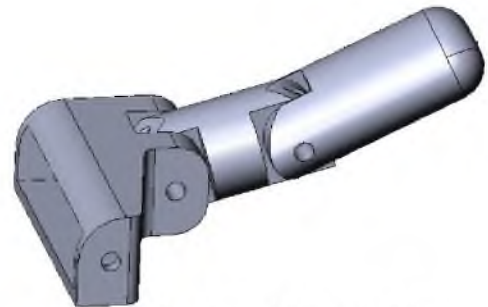


Fig. 3 Thumb model in assembly

The guide holes have been included in the finger design to optimize the tendon orientation and prevent the tendon lines from reaching the acute edge.

Each finger is connected to the palm, which is depicted in Fig. 4, with polypropylene pins. The lower part of the palm includes a part of the mechanism of rotation of the wrist.

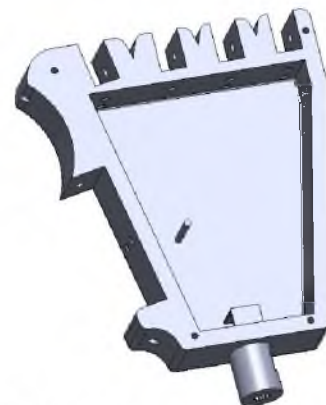


Fig. 4 Model palm prosthesis without lid

To ensure the maximum possible turn of the hand ± 90 degrees, it was decided that the noodle will be put directly on the shaft of the servomotor, as shown in Fig. 5. This is required to ensure the rotation of the brush in both directions in accordance with the specified parameters.

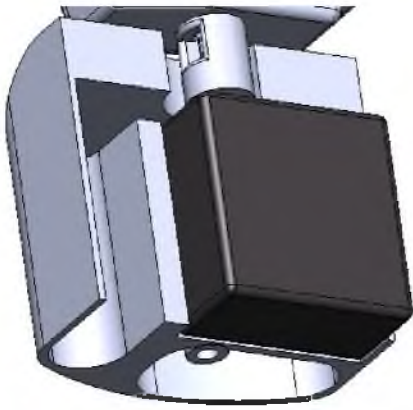


Fig. 5 Wrist model without lid

III. DEVELOPMENT OF 3D REPLACEMENT WITH INTERNAL COMBINATION

The forearm section, depicted in Fig. 6, does not contain moving components, it requires placing five servomotors and assembling them. The forearm is divided into separate components, which can be connected by means of special fasteners.

The gearbox, depicted in Fig. 7, is part of the elbow rotation mechanism and is glued to the forearm with a high-strength glue.

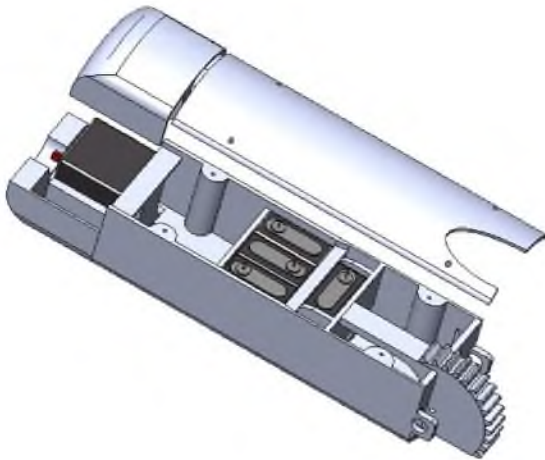


Fig. 6 Detailed model of the forearm of the prosthesis

The tendons wrap special three-dimensional printing chips, creating a closed loop. When the servomotor rotates in one direction, it pulls the tendons and closes the finger. To open the finger, the engine rotates in the opposite direction.

Large, index and middle fingers are connected to individual servo motors. Since the inner space of the hand is limited, the nameless and the little finger were tied to a single servomotor, therefore, they open and close in the tandem.

The TowerPro servomotor provides a torque of 10 kg / cm. To raise a hand with one servomotor, a transmission must be implemented. The mechanism allows us to generate more torque (turning force) at the expense of speed. The small gear, pressed against the servo motors of the biceps, leads to the movement

of a large section of the transmission associated with the forearm. The toothed gear is developed, which increases the torque from the servomotor 2 times.

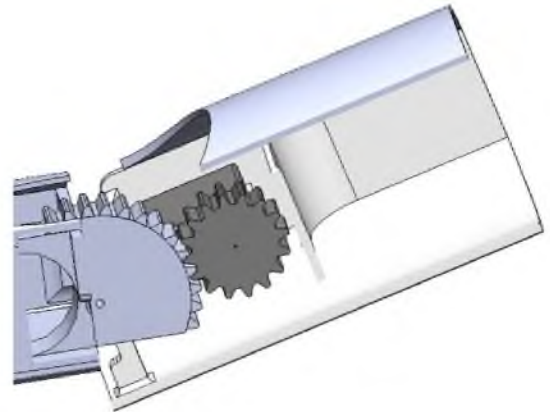


Fig. 7 Type of crossing of the site of the elbow

The servomotor of the elbow must be modified, and mechanical blocking must be removed from it. A potentiometer that provides feedback to the internal chip, which controls the rotation of the engine, has been removed from the inside and installed in the groove on the large gear.

By installing the potentiometer in the forearm, we changed the feedback angle of the servo motors. The potentiometer is now rotated 2.1 times slower than before, which leads to an increase in the servo range of 380 degrees - more than enough to move the elbow.

CONCLUSION

A detailed 3D model of bioelectric prosthesis was developed, which was divided into the following stages:

- the development of a 3D model of the brush, which consists of 17 elements of the model, namely, 3 elements per finger, a bow and cover to it;
- 3D model of forearm, which consists of 5 elements of the model and 5 internal components;
- Development of 3D model of the shoulder, which consists of 7 elements of the model and 1 internal component.

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