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Research Article

Customization of the Prosthetic Hand by Using 3D Printer

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Abstract

The purpose of this paper is to construct and program a prosthetic hand that can make various complex, coordinated movements based on command from sensors. The main objective of this scientific paper is to research and design a prosthetic hand prototype, including the development of algorithms for intelligent systems that will be used for self-control. As a product of this project is a prosthetic arm customized for a selected patient, which is able to meet some human requirements. And the same hand is given in service to the patient designed for daily use.

Keywords: *Prosthetic Hand; Programming; Algorithm; Customization; EMG Sensor*

Abbreviations

EMG: Electromyography

Introduction

Modern prostheses represent high-tech systems that significantly improve the quality of life of users. Researchers hope for further advancement using a more advanced interface that allows for better quality communication with the nervous system [1].

Today, hand and arm prostheses are more complex. The human hand is made up of a large number of nerves, ligaments, muscles and bones interconnected to form a precise instrument. Its re-creation through prostheses poses one of the greatest challenges of medical engineering. Michelangelo's hand prosthesis made by Ottobock Health care GmbH is very similar to the human one. It can perform seven different gripping movements. One motor moves the thumb, a second motor moves the other finger joints. The wrist can be fixed in different positions, and there is a slight movement that makes the movement very natural, for example when shaking hands [2,3].

Modern artificial limbs are typical examples of mechatronic systems with actuators, sensors, mechanisms and electronics. In terms of control, the challenge is to coordinate a multi-axis system. To minimize system complexity and central processor load, functions must be distributed in independent modules. In this case, the need to find the right balance between modulation and coordination is quite important.

Engines in artificial limbs serve a wide range of purposes. A special motor can move a clamp, a finger, or an entire arm or leg. A range of different engine shapes and sizes are put into use. For example, the motor in the connecting part of the hand must be relatively large and powerful. The motor in the hand can be small and light in order to reduce weight and inertia [4-8].

Materials and Methods

This study deals with the construction and programming of the prosthetic hand that will be able to perform several movements. The artificial hand must be able to have self-control through the use of the proposed algorithms that will be based on the microcontroller, but also on the body signals from the arm muscles.

Most of the artificial commercial hands that are available consist mainly of custom-made parts. The design and production of these parts make artificial prostheses very expensive. An artificial hand should be cost effective compared to local labor costs. In this paper the constituent parts of the artificial hand on the 3D printer, are designed and manufactured (Figure 1).

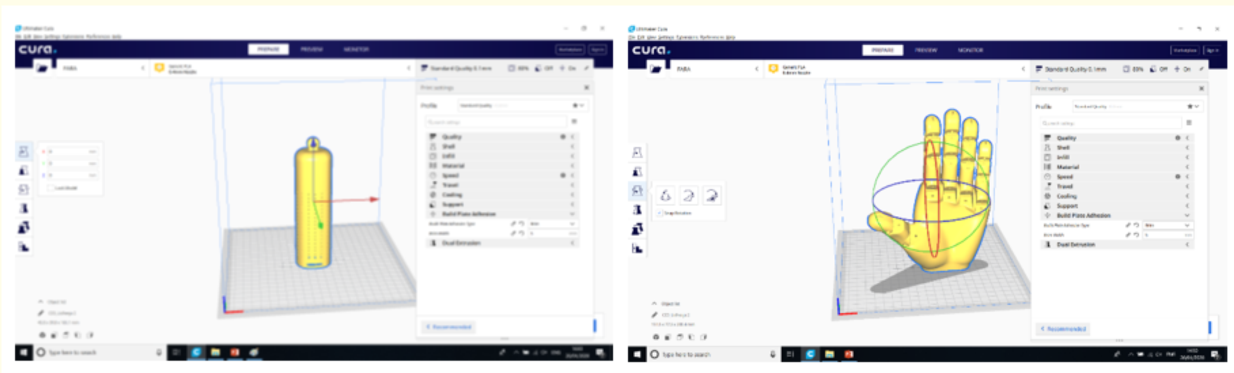

Figure 1: *Computer aided design of the prosthetic hand components.*

Also, electronics and interface controllers have been developed. For it's realization were needed a servo motor, Arduino micro, EMG sensor, battery, switch, and several wires (Figure 2). The Electromyography (EMG) sensor is used to measure muscle signals, that are then used by the robot to perform motion (open/close) (Figure 3). The electronic components have been mounted on Arduino micro board and the code has been compiled in C++ programming language.

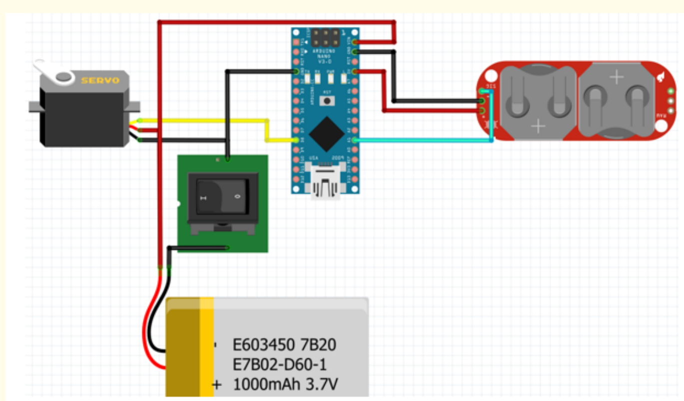

Figure 2: *Electronic scheme of the prosthetic hand.*

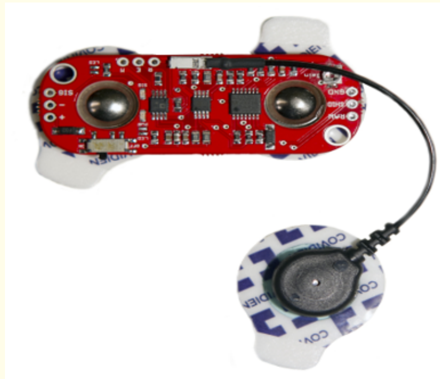

Figure 3: *MyoWare muscle sensor.*

Results and Discussion

After the design is tested, a program with Arduino C++ has been tested to control fingers movement. The fingers are controlled together to check the required gripping movements, that are usually used for everyday life. For everyday use, however, there is a need for further work. It is possible to cooperate with a prosthesis designers to make the arm extension from silicone and test it in order to be able to carry the prosthetic hand.

The workload, for the design of servomotor, has also been tested. Only very large objects with a diameter of 50 mm could not be grasped, since there is not enough friction between the object and the finger.

In figure 4 is presented the prosthetic hand that has no electronics, since the patient had the problems with watching, and the parents, asked only to use the prosthesis, not to damage the rest of the arm (Figure 5).

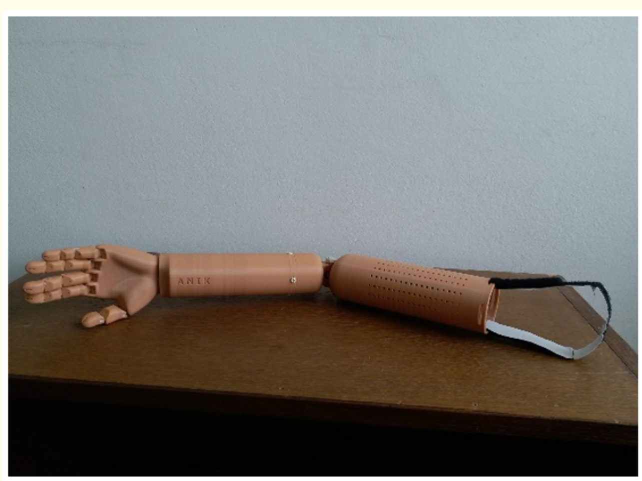

Figure 4: *Customized prosthetic hand.*

Figure 5: *The boy of 7 years old holding the prosthetic hand.*

In figure 6 is presented the prosthetic hand that is controlled by EMG sensor, in which case the prosthesis movement is coordinated by two arm muscles, where one is responsible for opening the hand and the other for closing. Muscle contraction generates an electrical impulse in the skin. This impulse is received by the electrodes attached to the skin and transmitted to the microprocessor in the prosthesis.

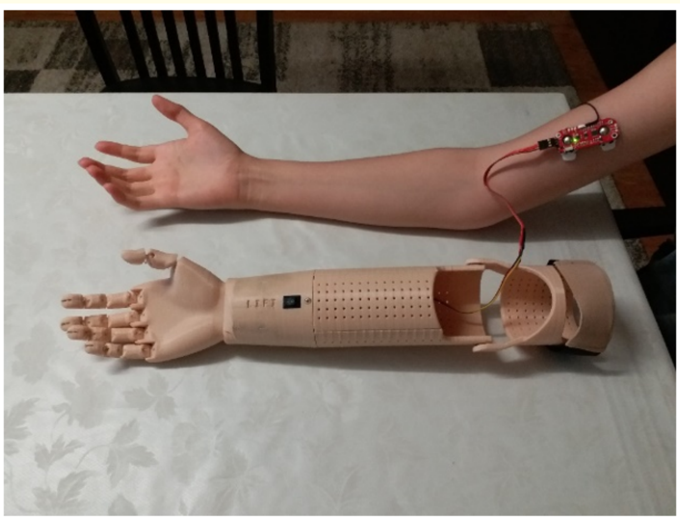

Figure 6: *Prosthetic hand controlled by EMG sensor.*

Conclusion

The output of this paper is the expertise gained to work prosthetic hands, then the use of various software for design and simulation of prosthetic hand.

They have designed and constructed costumed hands for selected patients and have been provided with atre services for daily use.

This experience would later serve to be able to use advancement in design and costume design while working other hands for patients in need.

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Conflict of Interest

There is no financial interest or any conflict of interest exists with regards to this paperwork.

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