DSTA 2021
dys-ta.com
16th INTERNATIONAL CONFERENCE
Dynamical Systems – Theory and Applications
December 6-9, 2021, On-line

Bionic hand control using EMG signals

Jędrzej Sencerek[1], Bartłomiej Zagrodny[2]

Faculty of Electrical, Electronic, Computer and Control Engineering, Lodz University of Technology, Stefanowskiego 1/15, 90-537 Lodz, Poland[1],
Department of Automation, Biomechanics and Mechatronics, Lodz University of Technology, Stefanowskiego 1/15, 90-537 Lodz, Poland[2],
208830@edu.p.lodz.pl[1]
bartlomiej.zagrodny@p.lodz.pl[2]

Abstract: Abstract. 3D printed prototype a human hand which is controled by sEMG signal was created to simulate two types of fingers motions. The first one includes fingers flexion/extension and the second one is focused on opposing the thumb. These two types of motions are executed by one pair of biological muscles, by the meaning of sEMG signals. The recruting electrodes are attached to both biceps brachii. One of them is responsible for fingers flexion/thumb abduction, and the other is for fingers extension/thumb adduction. The simultaneous contraction of both muscles couses a change in the mode of movement (fingers - thumb). Control is based on the Arduino microcontroller extended by two EMG Olimex shields and two servos. The main idea behind this project was to create an easy and cheap alternative to commercial prosthetic solutions.

Keywords: electromyography, bionic hand, 3D print, prosthetics

1. Introduction

The issue of upper limb amputation in Poland may seem to be a rare problem (in 2016, it was less than 1% of the population on the national scale [1], [2]). However, patients affected by this problem require specialized care, from the need of surgery and create a prosthesis, through social services, to the help of a psychologist. This is a very complex problem, where a functional prosthesis will help a lot. This project of myoelectric hand prosthesis is devoted to transradial amputation or wrist disarticulation. The aim of the prototype will be to simulate the movement of the fingers. Various solutions can be observed among commercial products. For example, the company Glaze Prosthetics specializes in printing cosmetic artificial limb, BeBionic or iLimb create myoelectric ones, and an important representative of mechanical ones is e-Nable - the open-source project, enabling volunteers to print their own prosthesis.

2. Results and Discussion

The prosthesis model was designed in CAD enviroment and printed on a 3D printer. The construction of presented artifcial hand limits the range of the motion in joints between phalanxes. The entire system consists of printed model, servos, Arduino UNO extended by EMG Olimex shield with electrodes that reads the signals from both biceps brachii muscles of the arms. The whole set is presented in Figure 1.

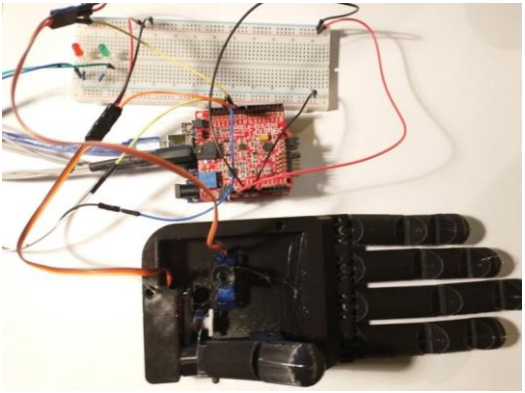

Fig.1. General view of the model with Arduino microcontroler and servos.

The prosthesis performs two types of fingers movement:

I mode - flexion and extension
II mode - abduction and adduction of the thumb

To switch the mode of motion the simultaneous contraction of the both muscles is needed. The estimations shown that the torque generated by servo to move fingers is approximately equal to 2.3% of torque of the weakest finger in the human body [3]. Despite this fact, the servo allows to move the prosthesis in full range of motion for demonstration purposes.

3. Concluding Remarks

The project uses an electromyographic signal to control two servos that drives the hand model. Despite its simple design, it has a full range of motion and the chosen solution allows for an easy control.

References

[1] The number of limb amputations comes from the IT system of the National Health Fund.: https://zdrowedane.nfz.gov.pl/course/view.php?id=5 (access: 11.11.2020).
[2] Szałtys D. and Rogalińska D.: Atlas Demograficzny Polski. GUS: Warszawa, 2017.
[3] Gedliczka A.:Atlas Miar Człowieka. CIOP: Warszawa, 2001.