GRASP CONTROL FOR MYOELECTRIC HAND PROSTHESES

B. Peerdeman*, S. Stramigioli, and S. Misra

*University of Twente, Drienerlolaan 5, 7522 NB Enschede, the Netherlands.
e-mail: b.peerdeman@utwente.nl, web: www.myopro.nl

ABSTRACT

A patient with a unilateral amputation will always prefer to use their remaining hand to perform most actions. The prosthesis is only used when support of the main hand is required. Therefore, the prosthesis should not aim to replace all functionality of the missing limb, but simply provide support and ease of use. Grasping is one of the most basic functionalities of the human hand, and is the main component of a large number of bimanual actions. A prosthesis that is easily controlled to perform various grasps can therefore be very helpful. In this research, various control systems are tested and evaluated. To test the control systems, a biomechanical model has been developed [1]. Its design is based on the structure of the human hand, containing five fingers with 3 flexion/extension degrees of freedom (DOFs) and one abduction/adduction DOF each. Several different high- and low-level control systems are tested on the model, and evaluated with regard to the functional requirements described in [2].

The control system can be divided into two parts: the high-level control system which determines the actions to be performed from the user's input signals, and the low-level control which determines joint and actuator torques based on the desired finger positions. When a grasp type is selected, the prosthesis should move the fingers to the right position to begin the grasp. This process is called preshaping. After preshaping is completed, the hand can be positioned around the object to be grasped, and the grasp can be closed. The grasp execution system should allow control of both closing and opening of the hand, as well as the application of additional force on a held object. After setpoints have been issued by the high-level control system, the low-level control needs to determine the correct motion and dynamic behavior of the fingers. The fingers should move to their end position quickly, naturally, and should react compliantly to any obstructions.

The high-level grasp control is tested by executing lateral, tripod and cylindrical grasps controlled by simulated EMG input. Position control, impedance control and intrinsically passive control are each implemented and tested by way of a simple grasping task for each grasp type. The improved performance of the latter control methods is demonstrated by grasping tests with objects of varying size, shape and stiffness. After the validity of both the high- and low-level systems is demonstrated in software, the completed control system is tested on the UB hand IV prosthesis prototype [3].

REFERENCES

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