Multigrasp hand sequential controller

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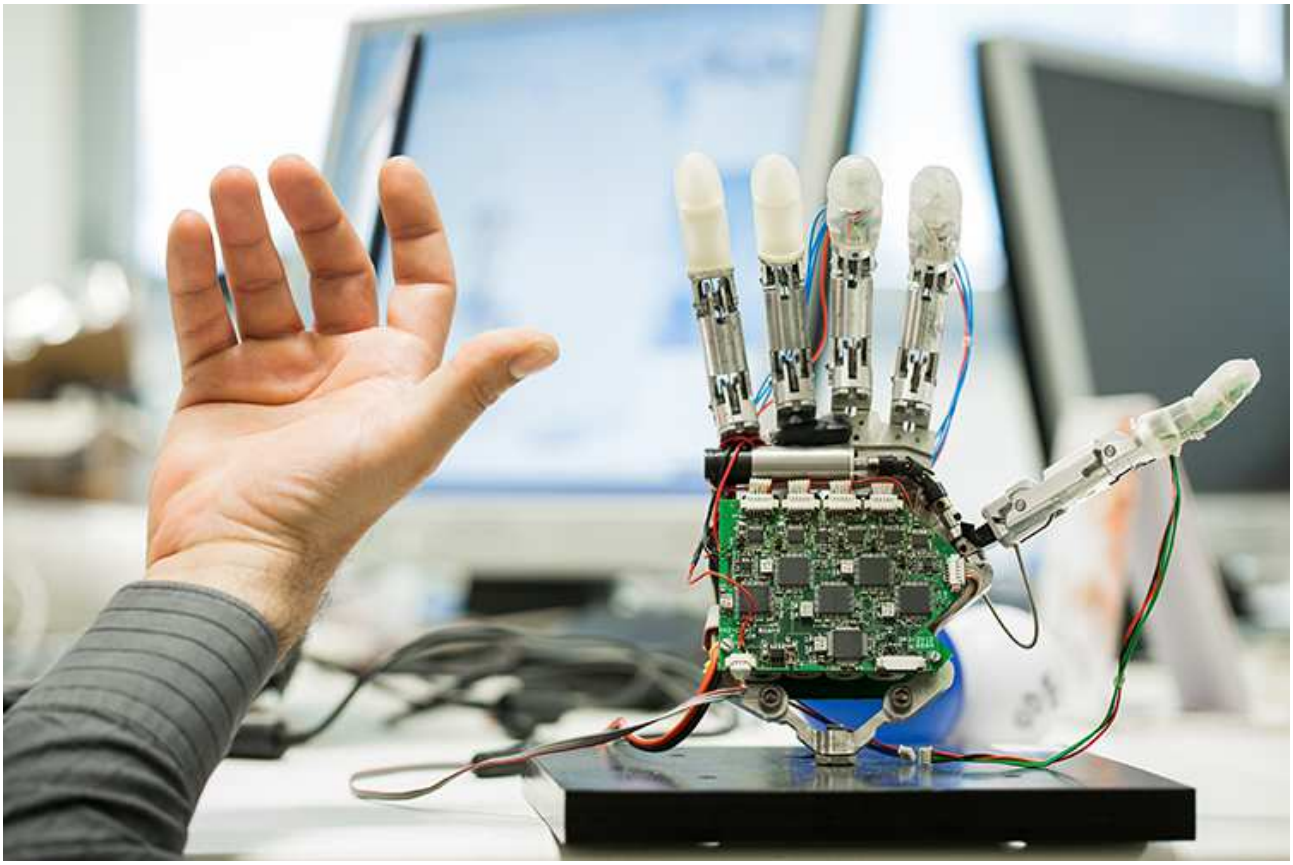

User Manual - IH2 Azzurra (Prensilia)

2020

1. Overview

The robotic hand system can sequentially select and perform one of three stereotyped grasping movements. The speed of the hand is directly controlled by the strength of user muscle contractions via EMG electrodes using a two-state amplitude-modulated control scheme. User-defined hysteresis thresholds for muscle activation are used to improve user intent detection performance. The system can be also connected to a computer to visualize and change the values of user-defined settings or to stream EMG data into a computer.

The overall system has three main components: (1) a robotic hand Azzurra IH2, (2) an electronic board and (3) an external personal computer (PC). The electronic board and the robotic hand must be connected to a power supply of 8 volts and a maximum current limit of 5 amperes. The EMG electrodes should be placed on the flexor digitorum superficialis and the extensor electrode on the extensor digitorum and carpi radialis longus and brevis.

The board can operate in two different conditions: interfacing with the robotic hand (hand mode), in which the user can control it as is summarized in Figure 1; or interfacing with the PC (computer mode) allowing users to interact with the system to exchange data. The system starts in hand mode upon powering-on. Transition between modes can be achieved easily by pressing the mode switch button. The indication of the current mode will be shown as ‘H’ (for hand mode) or ‘C’ (for computer mode) in the LED display unit.

Note: In hand mode operation, mode transition is only enabled during the preshape states (state 0, 2 or 4). If the switch button is pressed during any of the grasping states (state 1, 3 or 5), the prompt will be neglected for safety. The indication of the current state the system is in, will be shown again in the LED display unit. When switching from computer mode to hand mode, the display will show the ‘H’ indicating hand mode for a brief time-lapse after which it will indicate the hand current state as mentioned above.

In addition, when changing modes during normal operation, the user should follow the following recommendation to ensure proper functioning: unplug the hand serial cable and plug in the computer serial cable to the board only after switching to computer mode, and be sure to unplug the computer cable and plug in the hand cable before switching back to hand mode.

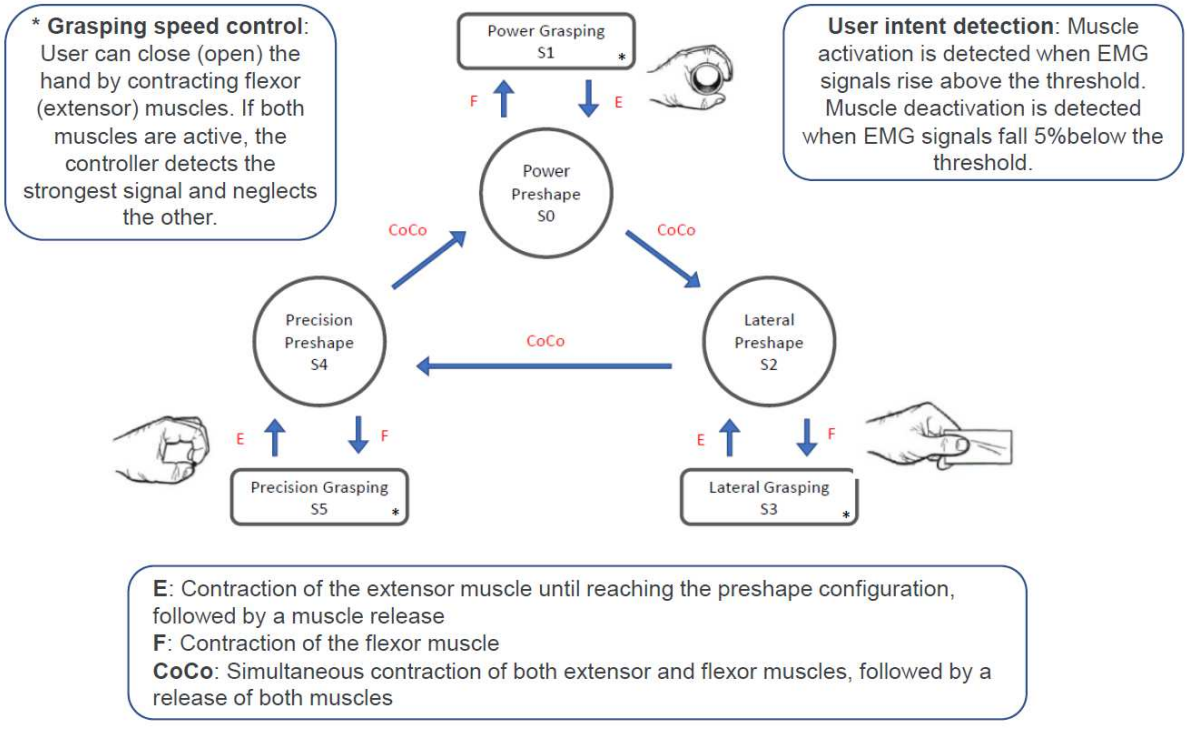

Figure 1. Hand mode user control scheme.

2. User-defined activation thresholds and EMG amplification: user protocol

For adaptability, the system allows the user to adjust the parameters given in Table 1 as needed (in computer mode). For example in case EMG signal(s) are insufficiently low, user can lower the threshold value(s) to decrease signal value(s) required for activation and/or increase maximum value(s) to amplify the signal(s). Although available, adjusting maximum values is not recommended. Instead, it is suggested to adjust the hardware analog gains on the sensors themselves, to exploit the hardware capabilities at its best.

Table 1. User-adjustable parameters, their descriptions, default values, and adjustable ranges in percentages

Parameter	Default Value	Range	Description
Extensor Threshold	50	6-100	Limit on signals for activation/inactivation to achieve intended tasks
Flexor Threshold	50	6-100	
Extensor Max Value	100	10-100	Maximum contraction to be amplified to full-scale
Flexor Max Value	100	10-100	

Allocation of the parameters of Table 1 should be done after investigating the appropriate values for the user. To this end, EMG signals can be streamed to the computer. Once the parameters are updated they are preserved after turn-off. The last saved values can be read through display operation. The aforementioned operations can be achieved by transmitting the correct sequence of prompts (see Table 2) through the serial port during computer mode.

Table 2. Communication protocol for computer-board interaction

Write in memory value of	0xAA	Percentage	0xAA	extensor threshold
	0xBB	Percentage	0xBB	flexor threshold
	0xCC	Percentage	0xCC	extensor max value
	0xDD	Percentage	0xDD	flexor max value
Stream signal of	0xEE	0xAA	0xEE	extensor EMG
	0xEE	0XBB	0xEE	flexor EMG
	0xEE	0xEE	0xEE	absolute difference between EMGs
	0xEF	Stop Streaming		
Display current value of	0xFF	0xAA	0xFF	extensor threshold
	0xFF	0xBB	0xFF	flexor threshold
	0xFF	0xCC	0xFF	extensor max value
	0xFF	0xDD	0xFF	flexor max value

Note: For the communication between the computer and device, software such as Realterm is required on the computer. While using communication software, make sure that the correct port where the device is connected is selected accordingly, the baud rate is 115200, and the display configuration is set to uint8 (for display operation) or uint16 (for streaming operation) in the software.