Modern Intelligent Hand Prostheses

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***Abstract*— Hand Prostheses.**

I. Introduction

II. Hand Prostheses

The MyHand was developed by the BioRobotics Institute of the SSSA and published in 2016. The goal was to design a dexterous lightweight hand prosthesis as an alternative to clinically available multi-grasp prostheses while using low-cost manufacturing processes and components wherever possible. To reduce complexity the hand carries three identical 8W brushless DC motors, one for the thumb, one for the index finger and one for the other three fingers. The functional components are hold together by a thin plate surrounded by a 3D-printed metallic mainframe and plastic covers for protection. The hand contains a sensory system for automatic grasp control and makes a future integration of a sensory feedback system possible, e.g. touch sensors in the fingertips. The motors are controlled by the master microcontroller which also acquires the EMG singals and communicates with the external world. The master microcontroller gains information about the actual speed and position of the motors from the slave microcontroller.
The force exerted at the fingertips is on average 31.4 N for the thumb, 11.7 N for the index finger and between 9.4 N and 14.6 for the other three fingers. The flexion/extension speed is 160 °/s for the thumb and 170 °/s for the other fingers, while the speed of the thumb while switching from the opposition to the reposition state can reach 250 °/s. The time needed to complete a grasp starting from the rest position is 270 ms for a lateral grasp and 370 ms for a cylindrical grasp.

Name	Developer	Year	Mass(g)	Size(mm) length x width x thickness	Number of joints	Degrees of freedom	Number of actuators	Actuator type
MyHand	SSSA	2016	478	200 x 84 x 56	10	4	3	Brushless DC Motor
Asto Hand v.1	Diponegoro University	2016	261	180 x 85 x 50	10	5	5	DC Motor
Bionic Hand	Atasoy et al.	2016	-	-	24	24	13	Brushless DC Motor
X-Hand	Xiong et al.	2016	-	human hand size	16	-	4	DC Motor
Six-DOF-Hand	Krausz et al.	2016	584	202 x 99 x 61	10	6	6	DC Motor
SoftHand Pro-D	Piazza et al.	2016	-	-	19	19	1	DC Motor
MORA Hap-2	Gopura et al.	2017	250	95 (fingers) x 83 x 25	14	11	4	-

Name	Number of Fingers	Joints per Finger	Actuators integrated	Transmission system	Sensor system	Gripping force	Individual Finger Force	Joint Speed / Closing Time
MyHand	5	1/2	Yes	Geneva drive	EMG/automatic grasp control	-	31N/ 12N	160-250 °/s
Asto Hand v.1	5	2/2	Yes	tendon spring	EMG	-	-	-
Bionic Hand	5	3/3	No	tendons	EMG	-	-	-
X-Hand	5	3/3	Yes	tendons	-	12.1N	-	1.2s
Six-Dof-Hand	5	2/2	Yes	gears/belts	EMG	-	4.12N	2.24 $rads/s$
SoftHand Pro-D	5	3/3	Yes	tendons	EMG	-	-	-
MORA Hap-2	5	2/3	Yes	four-bar linkage	-	-	-	-