OpenBionics: An Open-Source Initiative for the Creation of Affordable, Modular, Light-Weight, Underactuated Robot Hands and Prosthetic Devices

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ABSTRACT

OpenBionics is an open-source initiative for the development of affordable, light-weight, modular, underactuated robot hands and myoelectric prosthetic devices, that can be easily reproduced using off-the-shelf materials. The primary focus of the presented initiative is to propose designs that facilitate the creation of multiple low-cost task-specific robot hands instead of one that is complex and expensive. The proposed robot hands, efficiently grasp a series of everyday life objects and can be used for various applications that range from autonomous grasping and teleoperation, to humanoids, grasping capable mobile and aerial platforms, as well as for the development of affordable myoelectric prostheses.

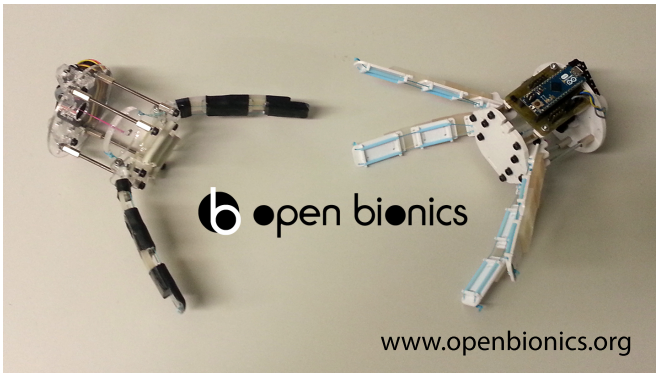

Fig. 1. Two different robot hands are depicted.

The proposed robot hands are created with different levels of anthropomorphism, following the directions provided in [1]. Design directions will be provided for simple low-cost robot hands that have only anthropomorphic fingers and/or placement of the finger base frames, as well as for anthropomorphic myoelectric prostheses. The robot hands design uses agonist and antagonist forces to implement flexion and extension of robot fingers. Steady elastomer materials implement the human extensor tendons and appropriate cables, implement the human flexor tendons. For materials selection, a compromise has been made, between affordable cost, lightweight design, high force transmission and adaptability. The flexible elastomer materials on the joints were selected to be lightweight but also stiff enough to produce a wide force range. For the fingertips, sponge-like tape and low-thickness rubber, were used to increase friction. Simple robot hands take advantage of a modular fingers basis equipped with 5 slots, which can be used to accommodate a total of four fingers. Thus, robot hands with different number of fingers and various finger base frames geometries, can be developed. Moreover, for the case of simple robot hands, a disk-shaped differential mechanism is employed in order to connect the independent robot finger cables with the actuator (servo motor), allowing for independent finger flexion motions, even in cases that one or multiple fingers are in contact with the object surface.

A series of experimental paradigms validating the efficiency of the proposed robot hands, as well as directions, CAD files, codes and necessary files for their replication, can be found at the official website of the OpenBionics initiative:

`http://www.openbionics.org` [1]

The experimental paradigms involve grasping experiments with everyday life objects using a four fingered robot hand, EMG based control of a three fingered robot hand, preliminary results with a grasping capable quadrotor, as well as anthropomorphic grasp planning with Navigation Functions based models, using a Mitsubishi PA10 7 DoF robot arm.

Regarding future directions, we plan to extract design principles for the creation of task-specific robot hands, using the optimization approach discussed in [2]. These task-specific robot hands will be "optimized" for specific robotics applications involving different object categories and of course tasks. Moreover we plan to develop an affordable five fingered anthropomorphic myoelectric prosthesis.

REFERENCES

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This work has been partially supported by the European Commission with the Integrated Project no. 248587, THE Hand Embodied, within the FP7-ICT-2009-4-2-1 program Cognitive Systems and Robotics.

[1] The website contains all the necessary information for the replication of our robot hands (CAD files, electronics, codes etc). The OpenBionics initiative is inspired by the open hand project of Grab Lab (Yale University), which was the first attempt (to the best of our knowledge) to create low-cost, open-source robot hands.