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COMPUTATION OF GRASP QUALITY METRICS IN OPENHAND SIMULATOR TO IMPROVE A 3D PRINTED PROSTHETIC HAND

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Summary: The evaluation of anthropomorphic hand designs should be focused mainly in their grasping ability. In the robotics community, many grasp quality metrics (GQM) that can be used for evaluating this grasping ability have been proposed in the research literature.
The aim of this work is to use the most relevant GQM to improve a 3D printed prosthetic hand, the IMMA hand [1]. The OpenHand Simulator [2] was used to simulate virtually and evaluate the grasps performed with the hand on 24 objects of the "Yale-CMU-Berkeley Object and Model Set" [3] that the authors have modeled in SolidWorks.
Different configurations of the IMMA hand were compared, evaluating the differences in the GQM, in order to improve its current design. Particularly, the thumb metacarpophalangeal (MCP) joint orientation, the addition of the abduction degree of freedom (DOF) in the MCP joints of the four fingers and the fixation of the distal interphalangeal (DIP) joints of the four fingers instead of having the current flexion/extension DOF, were analysed.
Analysing the results for up to 100 randomly selected successful grasps per object, we observed that changes in a range of 30º in the orientation of the MCP joint of the thumb had little effect on the GQM. The abduction of the MCP joints of the fingers in a range of 15º improved few of the GQM. Fixing the DIP joints of the fingers at 20º worsened most of the GQM.
This study shows that OpenHand Simulator is a powerful tool for evaluating the grasping ability of different configurations of anthropomorphic hands in order to obtain the best configuration for further redesigns. Moreover, having the models of the objects of the YCB set, provides a way to compare the analytical and the experimental evaluations of the anthropomorphic hands.

References:
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