A Comparative Analysis of Underactuated 3D Printed Hands

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The purpose of this experiment is to test the quality of 3D printed, underactuated hands from the Yale OpenHand library by comparing the removal force, print time and overall print quality of hands printed on three different printers; the Ender 5 Pro, Ultimaker 2 and the Stratasys uPrint. A design which hybridizes the base of the T-42 hand and the 2-finger 85 Robotiq model was created (in progress) to explore the effectiveness of the two-strut under-actuated gripper of the Robotiq model. The removal force was found by putting objects of various shape, size and material firmly in the hand's grasp, attaching force gauge to objects and pulling the force gauge until the object was removed. Warping was measured by measuring the height of a finger from each hand at 8 locations along the length of the finger and finding the percent error between each measurement and the theoretical height in Solidworks. In conclusion, the hand printed on the Stratasys uPrint outperformed the hand printed on the Ender 5 Pro which outperformed the hand printed on the Ultimaker 2 in both the removal force test and warping measurements. The elements printed with PLA filament outperformed elements printed with ABS filament in terms of warping. Various methods were used to remedy the glass build plate and openness of the Ultimaker 2 (which are not optimal for producing unwarped prints), but the most effective was 1 layer of painters tape on the build plate (to provide texture) and a makeshift insulator built around the printer from cardboard. An ANOVA test as well as Post-Hoc tests (Tukey) were performed and it was found that differences in removal forces for each printer and each object as well as all comparisons for both the object and printer factors were statistically significant.

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