3D Printed Variable Infill Soft Fingers for the SIMPA Prosthetic Arm

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Background

SIMPA (Soft- grasp Infant Myoelectric Prosthetic Arm) (Fig. 1), features soft-'fingers' made from silicone-rubbers (Fig. 2). The current manual multi-stage moulding process presents several practical challenges. The gripper is constructed out of two silicone-rubbers, producing a varying stiffness composite gripper. This work demonstrates the potential for 3D printing highly flexible soft-fingers, which utilise ultra-soft shore hardness 60A flexible filament (COEX Flex 60A) and variable infill to mimic the differing stiffnesses.

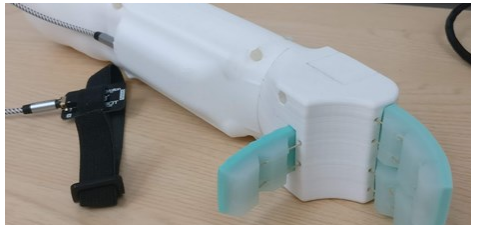

Fig. 1. SIMPA: Soft- grasp Infant Myoelectric Prosthetic Arm

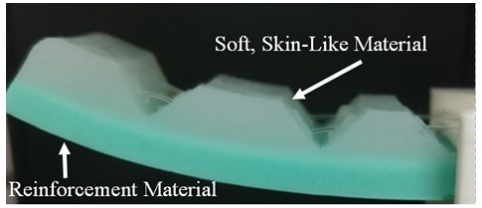

Fig. 2. Original Silicone-Rubber Soft-gripper Design

Methodology

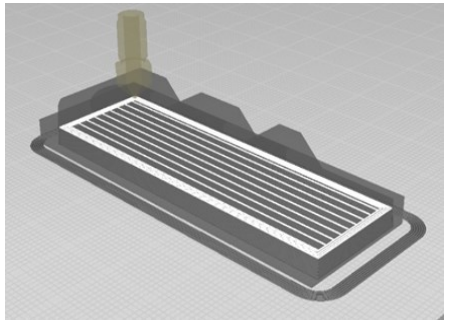

Fig. 3. Cura Model Displaying 25% Line Infill

The CAD model of the gripper is imported into Cura for pre-print processing. Within the Cura environment it is possible to adjust numerous print parameters. In an attempt to replicate the varying stiffness of the original grippers, the infill density differs, with 25% bottom reinforcement structure (Fig. 3) and 0% for the top facing contact pads.

The gripper (Fig. 4) was manufactured on a Lulzbot Taz 6, modified with a Flexion Extruder. The gripper is produced in approximately 2 hours; this compares to an average of 2 days when manufactured using silicon-rubber.

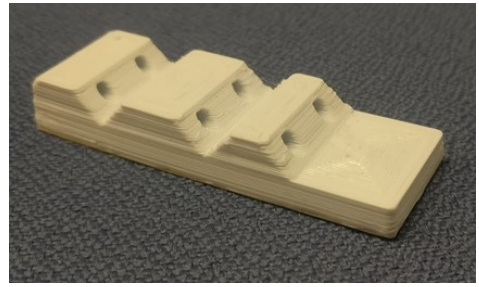

Fig. 4. Initial 3D Printed Soft-Finger

From an initial manual inspection (pulling on a cable threaded through the gripper), the printed grippers appear to be slightly stiffer than the silicon version. This initial print has not been optimised, but it is assumed that further refinement will improve the performance.

Future Work

Going forward a study comparing print parameters such as infill type and density, would be used characterise this relationship. This study would serve a more general purpose to characterise the material's use in FDM printing. This could be used in the design of general purpose soft-grippers and in other applications where variable stiffness may be required.

The additive manufacturing approach also removes many of the design limitations that come with silicon moulding, allowing for smaller scale grippers which may be used in a 5 digit version of the SIMPA prosthetic device.

References

D. De Barrie, R. Margetts, and K. Goher, "SIMPA : Soft-Grasp Infant Myoelectric Prosthetic Arm," in *2020 International Conference on Robotics and Automation (ICRA)*, 2020.

M. Manti, T. Hassan, G. Passetti, N. D'Elia, C. Laschi, and M. Cianchetti, "A Bioinspired Soft Robotic Gripper for Adaptable and Effective Grasping," Soft Robot., vol. 2, no. 3, pp. 107–116, 2015.

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