MULTI-MODAL FLEXIBLE ROBOTIC GRIPPER

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PROBLEM STATEMENT

In the food industry, produce can be fragile with irregular geometries. Traditional robotic grippers provide a lot of force and are inefficient at manipulating small to medium sized objects. Due to unpredictable variations in size, shape and hardness of produce, packaging has traditionally been done by hand and although effective, the process is time consuming and costly. With improvements to current flexible gripper designs, grasping irregular shaped semi-rigid objects could be completed more efficiently by a robot.

OBJECTIVES

Constraints:
- Complete design, building and testing of the gripper within the allotted time frame
- Robotic gripper must meet safety regulations

Criteria:
- Maximize surface contact between the gripper and objects
- Maximize the amount of unique geometries that the gripper can manipulate

DESIGN SOLUTION

“Flexible” and “multi-modal” are the two keywords the gripper is solely designed after. Multi-modal means that the robotic hand has multiple systems controlling the opening and closing of the fingers. This allows the gripper to have a wide range of applications using its two different grasps; pneumatics for the compliant grasp, and a linear actuator for the power grasp.

The power grasping solid silicone fingers made of Smooth-Sil 940 have cross-hatched struts to give a soft and deformable grip which bends around objects instead of crushing them. The compliant fingers are made of Dragon skin 10, a much softer silicone that is designed to curl when the hollow chambers are filled with air.

Due to the unique geometries of the fingers, 3D printing and injection molding techniques were utilized for the manufacturing process. Single and three-pieced molds were created in SolidWorks for the linear and pneumatic actuated fingers respectively.

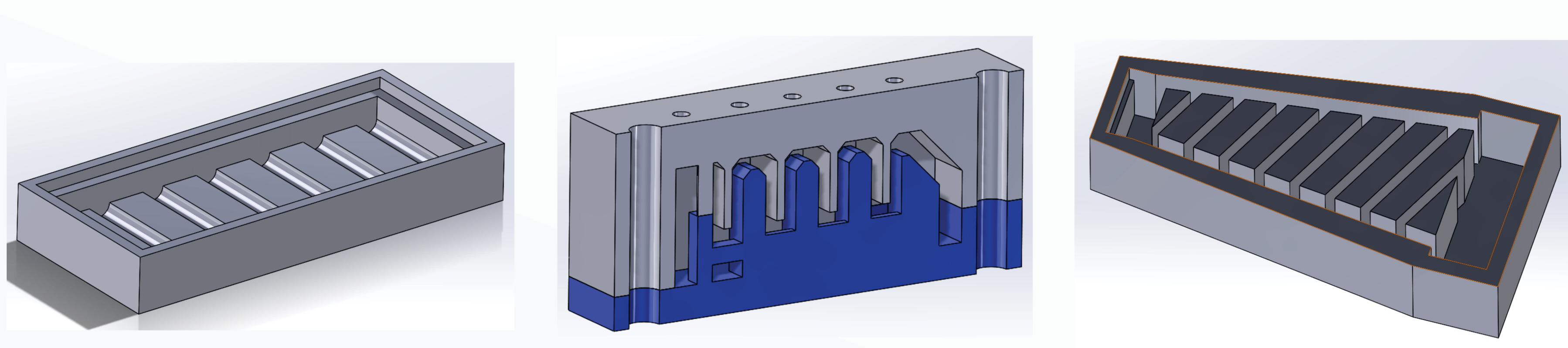

Figure 1: 3D printed molds used for silicone casting of flexible gripper fingers.

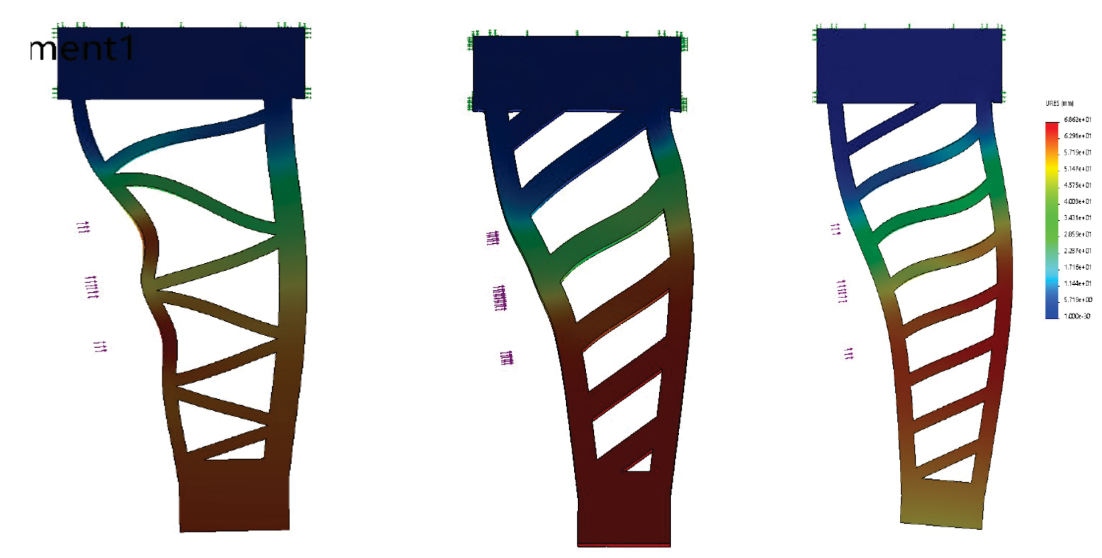

Figure 2: SolidWorks static structure analysis results for various truss geometries.

RESULTS

The flexible gripper was tested following a systematic process to determine the limits of the design. The test specimens were chosen to cover a variety of shapes, sizes, and textures to determine the grippers’ capabilities in both the power grasp, and the compliant grasp.

Table 1: Systematic test results.

Object	Weight (g)	Grasp Success		Object Damage
		Power	Compliant	
Light Bulb	36	N/A	Y	N
Golf Ball	46	N/A	Y	N
Tomato	151	Y	Y	N
Pepper	192	Y	N	N
Grapefruit	287	Y	N	N
Small Can	348	Y	N	N
Big Can	931	N	N	N
Water Bottle	665	N	N	N
Water Bottle	520	Y	N	N
Water Bottle	423	Y	N	N
Water Bottle	333	Y	N	N

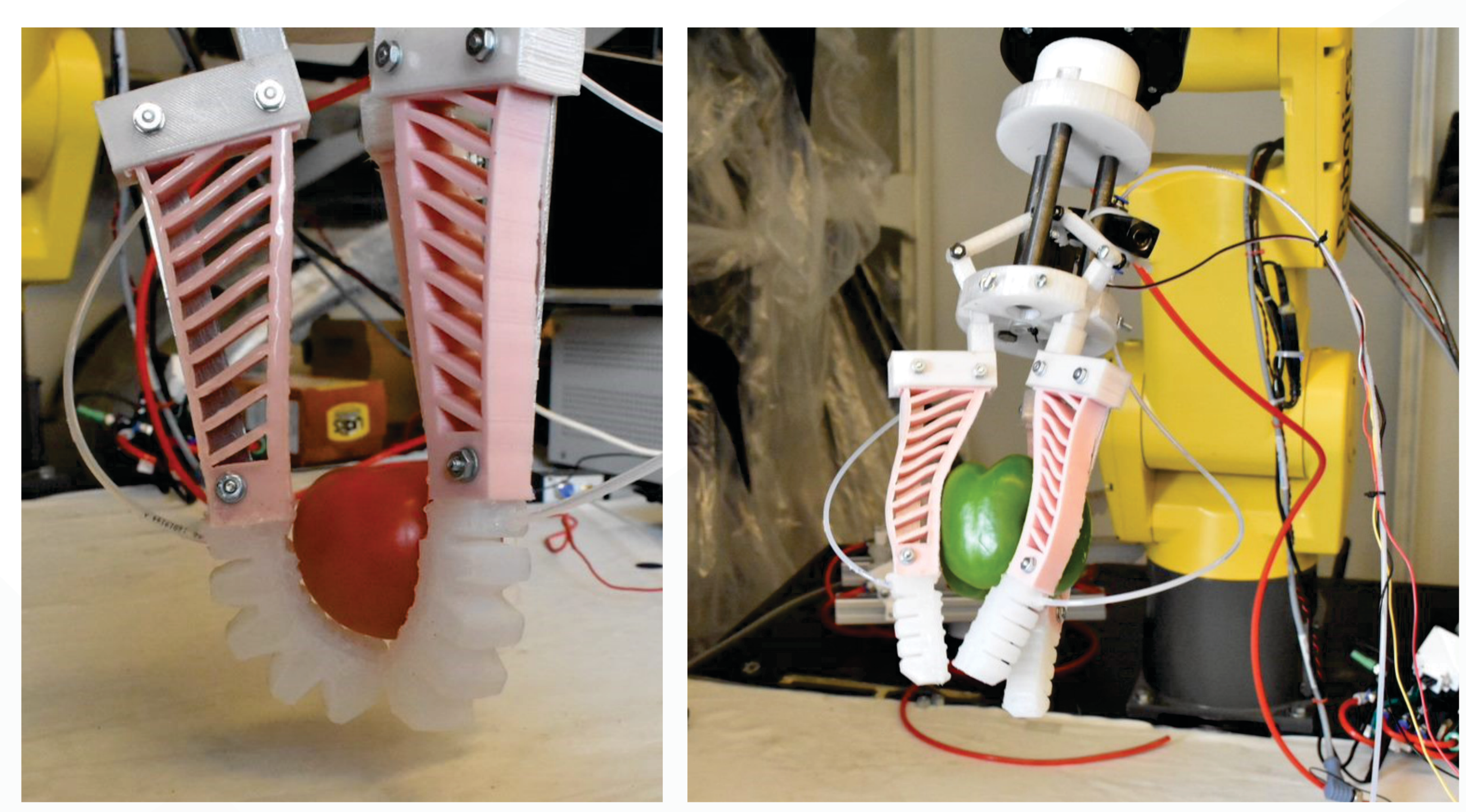

Figure 3: Multi-modal flexible gripper prototype testing.

FUTURE WORK

To continue the development of the gripper for better applications more iterations of the design will be made. Tactile sensors can be added to control pneumatics and linear actuation more accurately. The pneumatic fingers can be redesigned to allow for vacuum retraction and a better power grasp on all objects.

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