Adaptable Multi-Modal Robot End-Effector

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Problem Statement

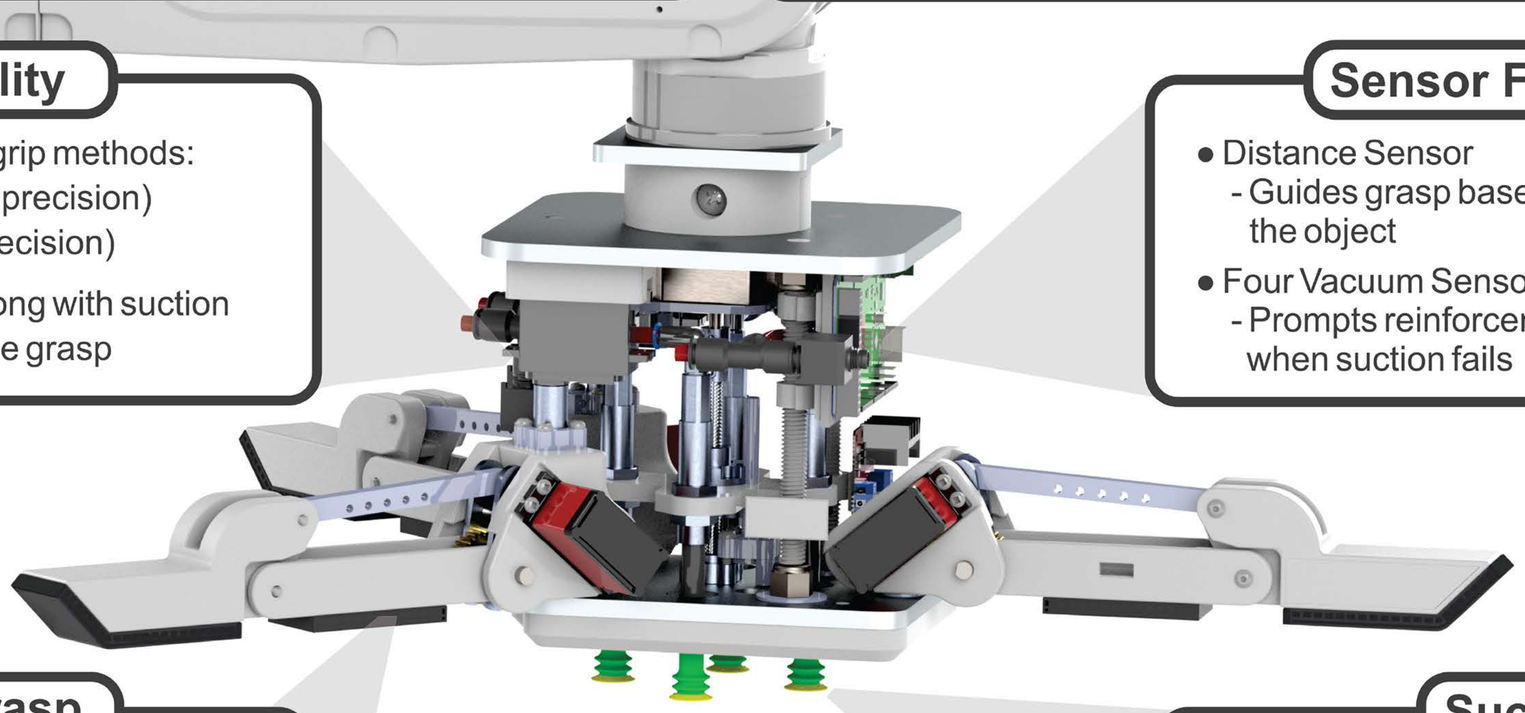
End-effectors with only a single method of grasping objects struggle in non-ideal scenarios. These scenarios include:

- Grasping objects:
  - with a diverse range of shapes, sizes, weights, and surfaces
  - that are clustered together, or in a cluttered environment
- Maintaining grasp during:
  - changes in loading, caused by a shift in centre of mass
  - high speed movement

Design Objectives

Design, manufacture, and validate a novel end-effector that has the following characteristics:

- Can grasp rigid objects
- Has multiple methods of grasping objects (multi-modal)
- Uses sensors to provide feedback and guidance
- Can thrive in scenarios where single method end-effectors commonly fail



Adaptability

- Five motors create four grip methods:
  - Parallel grip (wide and precision)
  - Point grip (wide and precision)
- Pairing a grip method along with suction capabilities reinforces the grasp

Sensor Feedback

- Distance Sensor
  - Guides grasp based on distance from the object
- Four Vacuum Sensors
  - Prompts reinforcement from the fingers when suction fails

Finger Grasp

- Three-finger gripper designed for a high precision grasp
- The under-actuated design allows for better compliance
- Finger pads compress to increase compliance

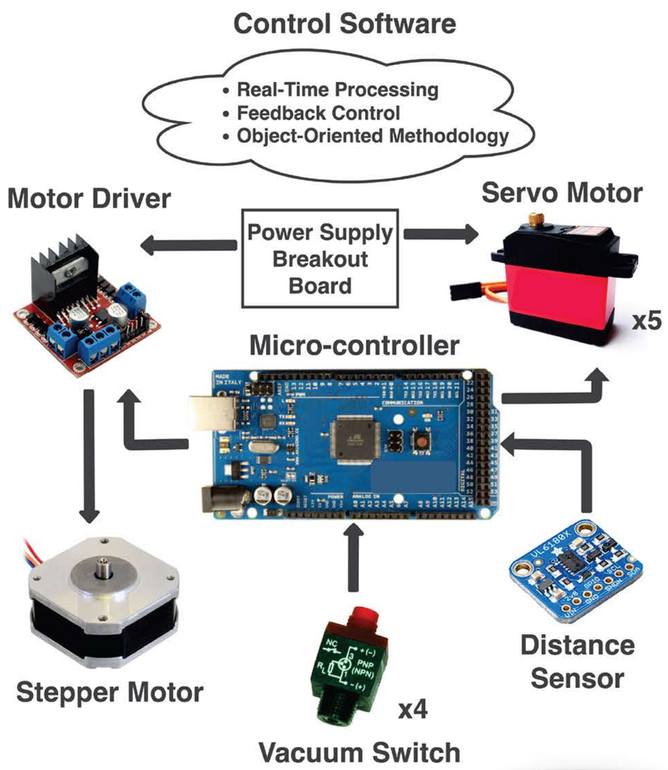
Suction

- Four suction cups mounted to a raisable platform within the palm
- Suction assembly retracts when not in use
- Four level compensators used to conform to non-planar geometries

Results

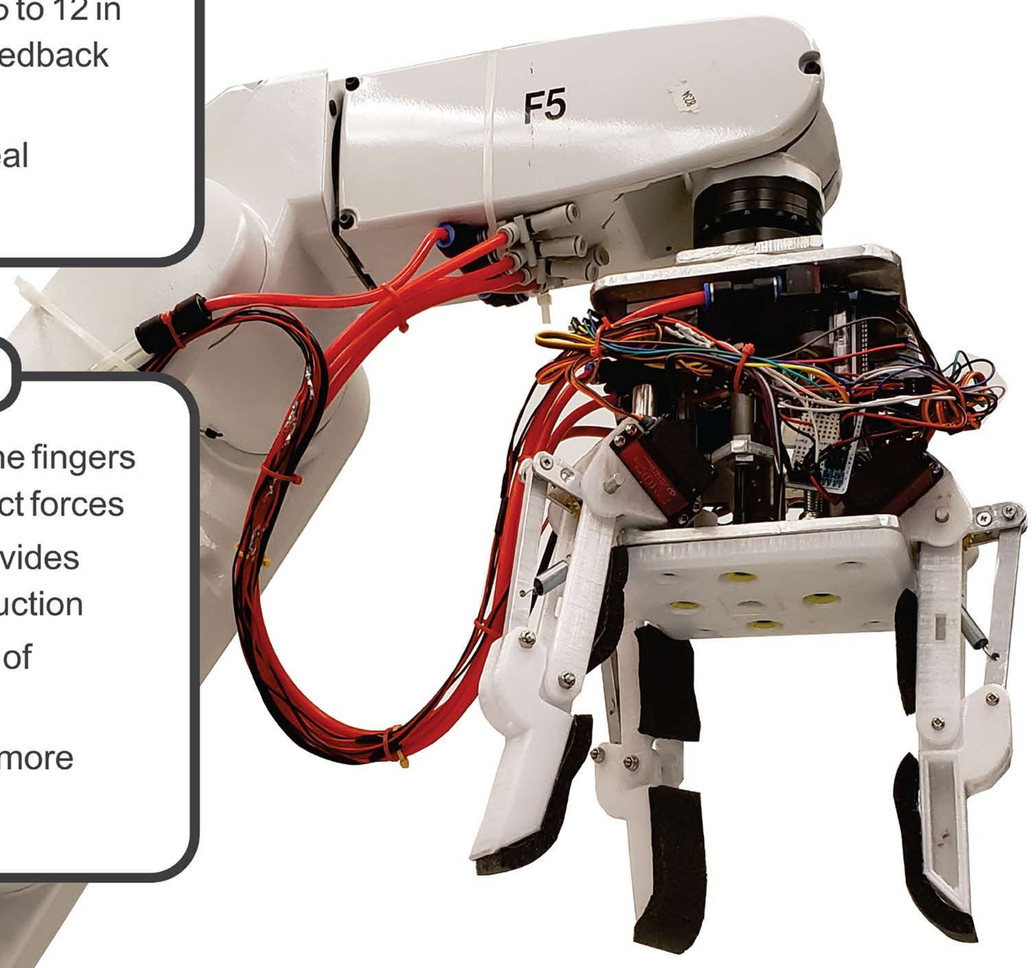
- Design performs well with rigid objects
- Two methods of grasping:
  - Suction capable of lifting 0 to 2.0 kg
  - Gripper capable of lifting 0.5 to 12 in
- Sensors provide valuable feedback during operation
- Design effective in all non-ideal scenarios specified

Control Overview



Future Work

- Interface tactile sensors on the fingers to provide feedback on contact forces
- Incorporate a sensor that provides variable force acting on the suction
- Optimize the size and weight of design components
- Expand capabilities to cover more non-ideal scenarios



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