

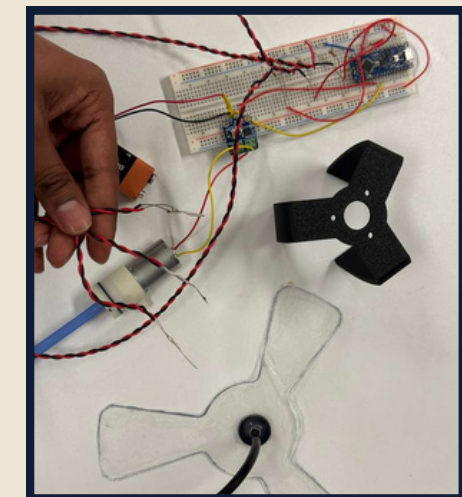
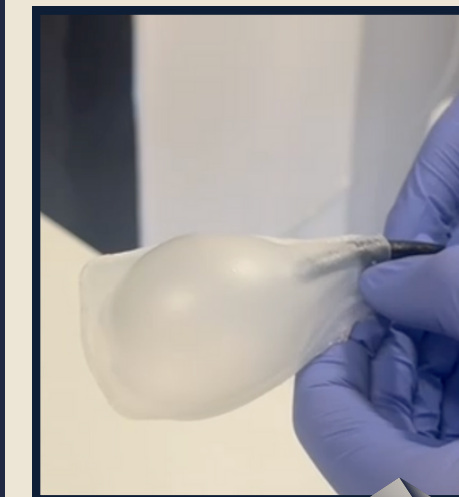
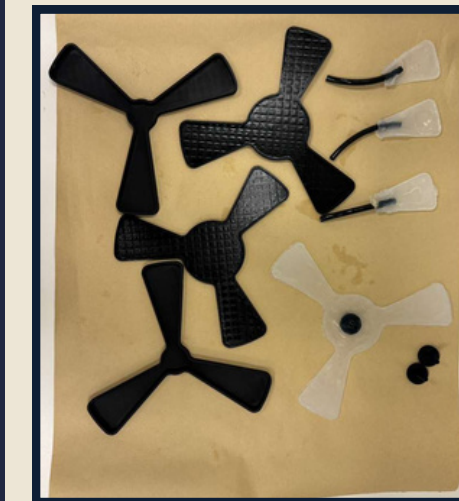
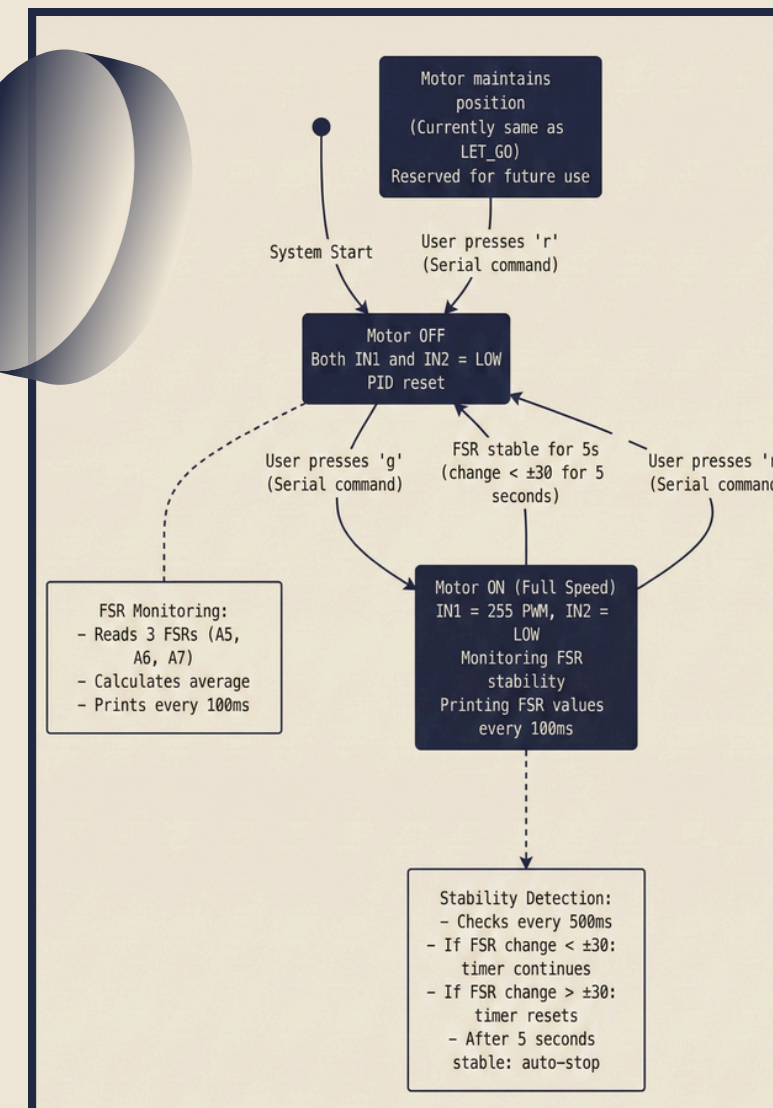
AirBear: Shape-Adaptive Grasping via Inflatable Actuation

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DESIGN CONCEPT: Inspired by soft body organisms that can adapt to various terrains, our design focuses on solving the issue of robotic end effectors' inability to pick up fragile, asymmetrical, and abnormal objects up accurately and consistently. Common grippers fail to detect object fragility and struggle to grip objects with even pressure, leading to breaking or slipping.

TECHNICAL FEATURES: Our core morphing mechanism is a pneumatic soft robotic hand. Petal shaped inflatable chambers made of soft silicone expand outward when pressurized allowing continuous geometric morphing. The petals distribute contact forces evenly while force sensing resistors (FSRs) on the outer dome measure pressure exerted on the object of focus. As rate of change of pressure (dP/dt) becomes constant, inflation is stopped.



IMPLEMENTATION OVERVIEW: The gripper was fabricated using 0.7 mm silicone sheets cut out to a custom gripper shape bonded with silicone adhesive forming chambers and interfaced to a 3D-printed nozzle adapter and tubing. Actuation was driven by a small DC air pump via an Arduino Nano & motor driver to inflate the chambers, with an FSR serving as the input sensor for pressure detection & state transitions. For evaluation, we tested each subsystem sequentially— validating the sensors, then the motor driver, then sensor–motor interaction, followed by motor actuation with inflatable chambers, and finally the fully integrated gripper.