PROJECT ABSTRACT

Soft Pneumatic Gripper

A soft pneumatic gripper with cast silicone bellows fingers on a 3D-printed frame — a mini air pump inflates the chambers so the fingers curl gently around light, delicate objects.

01. Title

Soft Pneumatic Gripper

02. Introduction / Background

Rigid robot grippers crush what they cannot model: fruit, eggs, soft components and medical samples all need compliant handling. Soft robotics answers this with flexible actuators — silicone fingers that bend when inflated, conforming to the object instead of forcing it. This project makes that frontier accessible: the student casts bellows fingers in silicone molds, mounts them on a 3D-printed frame, and drives them with a mini air pump and simple valve control.

03. Problem Statement

Conventional grippers are position-controlled and unforgiving, while commercial soft grippers are research-grade and expensive. A student-buildable soft gripper — molded silicone fingers, 3D-printed frame, low-cost pneumatics — demonstrates compliant grasping honestly at college scale and teaches molding, pneumatics and gentle-force handling.

04. Objectives

- Cast three silicone bellows fingers from 3D-printed molds with internal air chambers.
- Build a 3D-printed palm/frame with pneumatic fittings and tubing.
- Drive the fingers with a mini air pump and valve control for inflate/hold/release cycles.
- Demonstrate gentle grasping of light, delicate objects (design target: up to ~100 g).

05. Proposed Methodology

Bellows molds are 3D-printed and silicone is cast in two halves, then bonded to form sealed air chambers with embedded tubing ports. The fingers mount radially on a 3D-printed palm. A mini diaphragm pump pressurizes the chambers through a solenoid valve; inflating the bellows curls the fingers inward, and venting releases. An Arduino sequences inflate/hold/release, and the student tunes pressure for a secure but gentle grip.

06. System Architecture / Working

- 3D-printed molds → cast silicone bellows fingers with air chambers
- Fingers mounted on 3D-printed palm/frame with pneumatic fittings
- Mini air pump → solenoid valve → tubing → finger chambers
- Arduino controller → inflate / hold / release sequencing

07. Hardware / Software Requirements

- Food-safe silicone rubber, 3D-printed molds and palm/frame
- Mini diaphragm air pump, solenoid valve, pneumatic tubing and fittings
- Arduino (valve sequencing), 12 V supply for pump
- Arduino IDE firmware; pressure gauge for tuning (student side)

08. Expected Outcomes

- Three working silicone bellows fingers that curl on inflation.
- A complete gripper that picks and holds light, delicate objects (design target up to ~100 g).
- Documented molding procedure with photos — the fabrication is part of the deliverable.
- Complete report, PPT and viva Q&A; on soft-robotics principles.

09. Applications

- Demonstrating compliant grasping for robotics coursework and exhibitions.
- Handling delicate items (fruit, eggs, soft parts) in student automation demos.
- A platform for experimenting with pressure-based grip control.

10. Future Scope

- Add fingertip pressure/force sensing for closed-loop gentle gripping.
- Mount the gripper on a small robot arm for pick-and-place demos.
- Experiment with multi-material fingers (stiff backing + soft contact layer).