# FlexiGripper

Kshaf, Salma (School: El Shaheed Eid Fathy School)

Most robotic grippers are either powerful or gentle, rarely both. Traditional rigid designs lack adaptability and often damage fragile objects through excessive force, limiting their usage in applications like food processing, healthcare, and industrial automation. Soft robotic grippers offer improved compliance for delicate and irregular objects; however, constraints in load capacity limit their use in tasks requiring higher gripping force or load-bearing capability. This study presents FlexiGripper, a bio-inspired soft robotic gripper with dual-chamber silicone fingers inspired by human finger joints. It allows both pinch grasping for small objects and envelope grasping for larger ones. To address the load capacity problem, a fish-vertebrae-inspired endoskeleton was embedded into each finger, which increases stiffness while keeping the finger flexible. The gripper is integrated into a fully automated system: an AI vision module detects objects and selects the appropriate grip mode, which is executed through microcontroller-driven pneumatic actuation with real-time force feedback for safe grasping. Experimental testing demonstrated that each soft finger can carry loads of up to 3.5 kg while achieving large bending angles, with a tip chamber force output of 4.5 N. Both grip modes handled objects of different sizes and fragility levels without damage. The gripper was fabricated at 81–91% lower cost than commercial alternatives. FlexiGripper brings together bio-inspired soft design, an embedded endoskeleton, sensor feedback, and AI control into a system that is both strong and gentle, with validated performance at reduced cost.

**Awards Won:**
Second Award of $2,400
King Abdulaziz &amp
his Companions Foundation for Giftedness and Creativity: Full Scholarship from King Fahd University of Petroleum and Minerals(KFUPM) (and a $400 cash prize)
King Abdulaziz &amp
his Companions Foundation for Giftedness and Creativity: NOT TO BE READ -- $400 cash prize for each Full Scholarship from King Fahd University award recipient