Soft End Effector

SofTech Robotics - Dr. Colleen Berg

Objectives & Benefits

Objectives:
- *Creating a soft end effector for a six-degree-of-freedom robotic arm*
- *One of the few international teams working with KL University located in India*
- *Soft end effector that is adaptable with any robotic arm it attaches to*

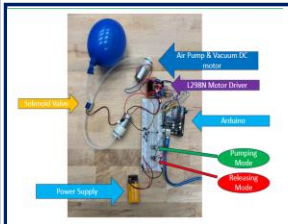
Benefits:
- *Lifting objects without causing any damage*
- *Can be used for industrial use like handling foods*

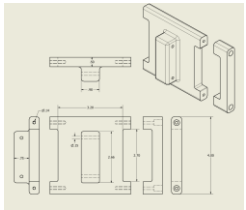
Technical Requirements & Engineering Characteristics

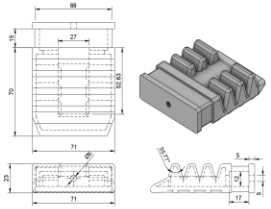
Technical Requirements:
- *Lifting objects without causing damage*
- *Adapt to two different robotic arms*
- *Using a vacuum pump and air compressor to provide movement to the end effector*

Engineering Characteristics:
- *Our Software of Choice was Fusion 360 for CAD modeling of components*
- *Fabrication of exponents were 3D printed*
- *GMU team is using VEX Robotics to demonstrate the end effector*

Schematics and 3D Models







Top Left: Pressure control system
Above: Hub
Left: Finger

Fabrication

VEX Robotics without end effector

Measuring silicon rubber for end effector fingers

End effector fingers attached to hub

Constructing the robotic arm

Prototype finger mold

Finalized finger

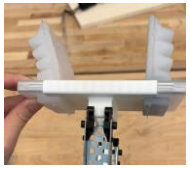
Technical Approach & Alternative Designs

Fingers:
- *Fingers are made of Eco Flex 00-30 silicon rubber, cast in 3D-printed molds. Each finger inflates to bend and conform around objects, mimicking soft tissue behavior.*

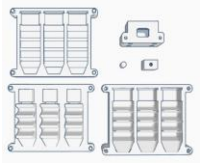
Pressure control system:
- *A pneumatic system controls finger movement . The system modulates air pressure to enable precise grasping*

Hub and VEX Robotics:
- *The soft gripper is mounted on a VEX Clawbot arm. A custom-designed hub connects the soft end-effector to the two moving beams, accommodating motion during extension and contraction.*

Alternative Design Considerations:
- *Considered various silicon types before selecting Eco Flex 00-30 for its elasticity and durability.*
- *Explored using different available robotic arm and considered buying pre-built robotic arm for the project.*
- *Considered different existing mold designs before the final version.*
  - *V1: individual fingers but was harder to provide movement for all fingers*
  - *V2: Three fingers connected as one. Trouble creating connection to the silicon rubber to the air tube*



Arm connected to hub and fingers



Version 1: Single Fingers

Version 2: Single tri-fingers

Results & Conclusions

Results & Conclusions:
- *The soft robotic end effector showcases how international collaboration, and innovative thinking can solve complex engineering challenges. Despite having no sponsor, team GMU and KL University worked across time zones to design an end effector capable of handling fragile objects using silicon rubber fingers and vacuum actuation.*
- *Through trials and refinements in mold design, curing techniques, and system integration, a functional end effector compatible with multiple robotic arms was successfully created. Highlighting the power of soft robotics in various applications (i.e. food handling, biomedical assistive technology, etc.).*
- *Moving forward, the teams plan to improve durability, integrate sensors for feedback, and explore wireless control using ESP32 and mobile app control are also in the works. With continued support and testing, the system could be miniaturized and tested on real-world application.*

Acknowledgements

- *Thank you to Dr. Kathir for allowing us to work with KL University to create an end effector*
- *GMU Faculty Advisor*
  - *Ms. Colleen Berg*
- *Special Thanks to*
  - *Mrs. Wendy Maitland*
  - *Mr. Johnnie W Hall IV*
- *Team Members*
  - *Peter Messier – Team Lead*
  - *Tan Chau*
  - *Eliana Miller*
  - *Paul Cueto*
  - *Aman Kodimela*
  - *Sobuj Mondal*
  - *Faizer Rahaman*