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Earning Daisy Girl Scout Robotics Badges with a Hands-on Soft Robot Gripper Design Activity (Resource Exchange)

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Thomas Tran is currently an undergraduate student at the University of Illinois at Urbana-Champaign in the Bioengineering department. He plans to attend the University of Chicago and pursue a Master's in Molecular Engineeging. His research focuses on utilizing soft robotics as a means to expose K12 students to engineering while addressing the gender disparities seen across several engineering disciplines.

Prof. Holly M. Golecki, University of Illinois at Urbana - Champaign

Dr. Holly Golecki (she/her) is a Teaching Assistant Professor in Bioengineering at the University of Illinois Urbana-Champaign and an Associate in the John A Paulson School of Engineering and Applied Sciences at Harvard University. She holds an appointment at the Carle-Illinois College of Medicine in the Department of Biomedical and Translational Sciences. She is also a core faculty member at the Institute for Inclusion, Diversity, Equity, and Access in the College of Engineering. Holly studies biomaterials and soft robotics and their applications in the university classroom, in undergraduate research and in engaging K12 students in STEM. Holly received her BS/MS in Materials Science and Engineering from Drexel University and her PhD in Engineering Sciences from Harvard University.

Build a Robot!

Dr. Holly Golecki, Elizabeth McNeela, Thomas Tran, Lucy Brizzolara

What is a Soft Robot? What is Bio-inspired Design?

In this three day activity, children can learn about how robots are used to help people perform daily tasks and how engineers use nature as inspiration for their design. Roll up your sleeves and build your own robot gripper in this hands-on curriculum. But these robots are not made from traditional nuts and bolts. Students will dive into the squishy world of polymers to build robots that are soft, and safe enough for us to use as wearable devices!

Ages 6-10

3 One-Hour Sessions +Instructor Prep Time

Learn About and Build Soft Robotics

Are you a Girl Scout troop leader helping your Daisy Girl Scouts to earn robotics badges?

These activities align with the three robotics badges: What robots do, How robots move, and Design a robot. Complete these activities to earn all three badges!

Are you a teacher looking to align your curriculum with the Next Generation Science Standards?

These activities fulfill ETS1-1-3, PS2, and PS3 as students design grippers, understand how forces produce robot motion, and how molecules come together to form polymers!

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What Robots Do | Day 1

Introduction

Day 1 begins with a brief introduction of soft robots, comparing the attributes to traditional mechanical robots while also highlighting their use in everyday products. The hands-on portion consists of students polymerizing and pouring the first layer of silicone into their 3D mold.

Materials Needed

- Cups
- Popsicle sticks
- Gloves
- Plastic tubing
- Mold
- Mold release spray
- String
- Zip ties
- Tablecloths
- Silicone
- CAD files (see QR code)

Before

- Instructors prepare silicone (follow instructions on QR code #1)
- Prepare classroom: set up tablecloths, each desk gets one supply kit

During

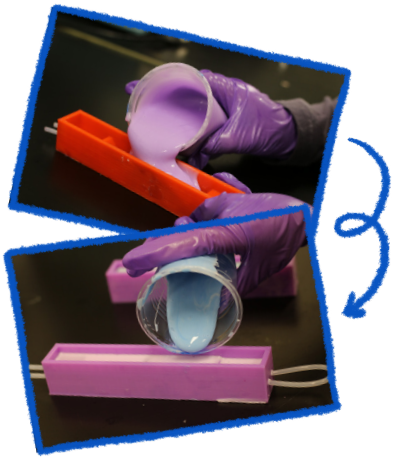
- Each scout gets two cups of part A and part B silicone, one popsicle stick, two gloves, and one prepped mold
- Mix both parts of silicone with popsicle stick to create polymer
- Pour silicone into the mold, approximately 3/4 of the way full

After

- Allow mold to cure for 10 hours
- Instructors fill mold with second layer of silicone

Key Conversation Points

- What do you imagine a robot looks like (size, shape, materials, etc)?
- Who do you think is building these robots?
- Introduce the idea of soft robotics: robots made using soft or flexible materials such as silicone
- Advantages of soft robots: can be safer and able to access spaces traditional robots cannot; able to move more fluidly than traditional robots
- Introduce actuators: device that converts physical movement when you add energy



Additional Resources

SDM Actuator Instructions

How to Make Molds

Materials List

Visit the Golecki Group research page for fabrication guides and more information on soft robotics!

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How Robots Move | Day 2

Introduction

Prior to Day 2, instructors should have added a second layer of silicone to the molds. The session begins with students demolding the cured double-layer mold. Students will lace through string to act as a cable, adding mobility of the actuator. Students will experiment with everyday items to test the functionality of the actuator.

Materials Needed

- Pliers
- Yarn needle
- String
- PVC tube
- Zip ties
- Objects for grabbing (scissors, pens, toys, etc.)

Before

- Set up students' cured molds from Day 1

During

- Remove plastic tubing in mold with either pliers or by hand
- Using pliers, remove the flat end of the actuator from the mold enough to be able to grip it
- Using flat end of actuator, pull the rest of the actuator away from the mold to remove it. Be careful to make sure there are no cracks in the actuator
- Using wire needles, thread string through the holes lengthwise so the string starts and ends at the flat end
- Zip-tie two grippers across from each other alongside a tube where they face inward. Pull the strings to allow the grippers to curl inward and meet

After

- Attempt to pick up variety of household objects with actuators
- Store actuators for future use

Key Conversation Points

- How do the actuators feel (texture, firmness, etc)?
- How do the fingers curl?
- What objects can the actuator pick up?
- What objects can the actuator not pick up?
- What generalizations can you make about the types of items the actuator can pick up?

Additional Resources

SDM Actuator Instructions

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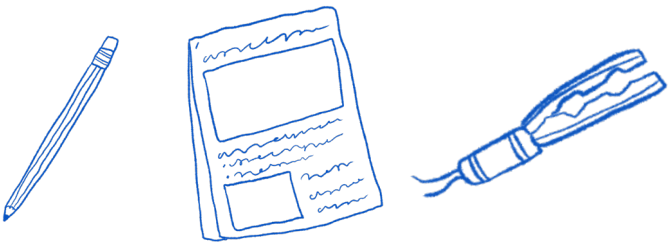
Design a Robot | Day 3

Introduction

Day 3 concludes the workshop by inspiring students with plant and animal features for potential modifications. Students will brainstorm bio-inspired additions based on what they could or could not successfully leverage previously.

Materials needed

- Bio-inspiration Worksheet (QR code)
- Student actuators
- Bio-Inspiration Presentation



Before

- Gather photos/videos of animals and plants with useful features (ex: Giraffe tongue, crab claws, bird talons, webbed frog feet, elephant trunk)

During

- Display and discuss interesting features of plants and animals and how they allow for more mobility, grabbing, and strength.
- Encourage students to reflect on the last session regarding what their actuator was and was NOT able to pick up
- Facilitate brainstorming individually and collaboratively, having students fill out the worksheet throughout.

After

- Send students home with their actuator!
- Continue discussion of robotics and their endless applications!

Key Conversation Points

- What features have animals adopted to move and grab more efficiently?
- How can we incorporate nature in robots?
- Where else can we draw inspiration from?
- What can we do to personalize our actuator?
- What are some steps we should take to test our brainstormed improvements?

Additional Resources

Bio-Inspiration Worksheet

Certificate of Completion!

Visit the Golecki Group research page for fabrication guides and more information on soft robotics!

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