an activity by Emily Lovell, Jie Qi, and Natalie Freed

PLUSH MONSTERS

creatures with character

Tools & Materials

For each student:

- battery
- battery holder
- piece of fleece (9" x 12")
- 1 or 2 LEDs (lights)
- *LilyTiny* sewable microcontroller

For the group to share:

- conductive thread
- fabric scissors
- hot glue gun and glue sticks
- needle nose pliers
- sewing needles
- embroidery floss
- polyester stuffing
- needle threaders or beeswax
- buttons and/or fleece scraps for embellishment
- black and red permanent markers

Summary

Students are exposed to microcontrollers and the concept of programmability. Each student will make a plush monster companion, using a sewable pre-programmed microcontroller to control the behavior of one or more LEDs.

Learning Goals

Students will...

- understand what a microcontroller is and how programming can add dynamic behavior to an e-textile project.

Preparation

- Gather the materials.
- If you plan to give students the handout or monster templates, print copies in advance.

Activity

1. If examples are available, begin by sharing those with the students.
2. Explain that a circuit is a continuous loop through which electricity can travel. Our circuits all have a power source, and for our purposes this will be a coin cell battery. Additionally, circuits can have outputs, such as lights and motors. As we design a circuit, our goal is to guide the electricity out of the battery, through any output components (like lights), and then back to the battery.
3. Point out that batteries and LEDs have a "positive" and a "negative" side. This is called *polarity.*
   - Positive is also referred to as +, *power,* or by using the color red. The positive side of an LED corresponds to the longer metal leg.
   - Negative is also referred to as -, *ground*, or

by using the color black. The negative side of an LED corresponds to the shorter metal leg.

4. Explain that connections should be made from positive-to-positive and negative-to-negative. Positive and negative connections should never touch or cross – this will cause a *short circuit* (which won't be functional).
5. Review the LilyTiny diagram and example circuit with the students. This can be done by distributing copies, projecting, or redrawing the diagrams on a chalkboard or whiteboard.
6. Ask students to sketch the electrical connections and placement of components for their monsters. If students decide to use one of the monster templates, they can sketch directly onto the template. Otherwise, students can draw their own monster outline of about the same size, and then sketch their circuit within it. It will be easiest to keep all of the components on one side of the monster (the front or the back). Students may also distribute components across both sides, as long as they carefully consider how to route the electrical connections around the edges.
7. Distribute the following to each student: battery, battery holder, piece of fleece, LilyTiny, and at least one LED. Make the rest of the materials available on a common table.
8. Direct students to cut out two matching fleece shapes; these will be the front side and back side of the plush monster. Students can either cut around one of the included templates, or use their own monster outline of about the same size.
9. Instruct students to curl the legs of their LEDs using the needle nose pliers so that the LEDs can be sewn to fabric. (See photo below for an example.)

a sewable LED whose legs have been curled with needle nose pliers

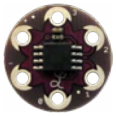
Red and black permanent markers can be used to color-code the positive and negative legs of each LED.

10. Suggest that students attach the components to their fabric with a dab of hot glue, being careful to leave the conductive parts of each component exposed.
11. Students can consult their sketches as they sew the connections between components and sew the components to the fabric. Make sure they sew each component securely to the fabric (similar to sewing on a button) as well as sewing between components. After sewing each connection, students should tie a knot on the fabric's backside and cut the thread.
12. After students have finished sewing, show them how to insert the battery into the battery holder (with the "+" side facing up).
13. If students' LEDs are lighting up as expected, instruct them to trim any loose thread ends and to put a dab of hot glue over each knot. This will help protect the knots from unraveling and will also prevent the thread ends from shorting the circuit.
14. Students can now begin to sew together the two sides of their monsters, using an embroidery needle and some embroidery floss. When stitching the edges together, it is important that the battery holder remain on the outside of the monster – otherwise, it will be impossible to replace the battery. Students should sew most (but not all) of the way around the edges, then pause to stuff their monsters with polyester stuffing. (A pencil or pen can be helpful in pushing the stuffing into corners, arms, and legs.) Once the monsters have been sufficiently stuffed, students can finish sewing the rest of the way around the edges.

This activity was developed at the MIT Media Lab with support from the National Science Foundation.

Emily and Jie are part of the High-Low Tech research group (hlt.media.mit.edu) and Natalie is in the Personal Robots research group (robotic.media.mit.edu).

TOOLS & MATERIALS

Item		Where to Purchase	Notes
batteries (CR2032)		Digi-Key[1] SparkFun[2] RadioShack electronics stores	• Digi-Key part #: N189-ND • SparkFun SKU #: PRT-00338 (or search for "Coin Cell Battery - 20mm")
battery holders		Digi-Key[1] SparkFun[2]	• Digi-Key part #: BA2032SM-ND • SparkFun SKU #: DEV-08822 (or search for "Coin Cell Holder - Sewable SMD")
conductive thread		SparkFun[2]	• SparkFun SKU #: DEV-08549 (or search for "Conductive Thread - 234/34 4ply") • this 4-ply silver plated thread is a good one to start with, although many varieties exist
embroidery floss		fabric & craft stores	
fleece		fabric stores	• felt will also work, but using fleece results in softer monsters
LEDs (lights)		Digi-Key[1] SparkFun[2] RadioShack	• Digi-Key part #'s: 160-1127-ND, 160-1133-ND, and 160-1131-ND (red, yellow, green) • SparkFun SKU #'s: COM-09590, COM-09594, and COM-09592 (red, yellow, green - or search for "Basic LED")
LilyTiny sewable microcontroller		SparkFun[2]	
needle nose pliers		SparkFun[2] RadioShack Sears hardware stores	• SparkFun SKU #: TOL-08793 (or search for "Needle Nose Pliers") • RadioShack catalog #: 64-062 (or search for "Mini Long-Nose Pliers")
polyester stuffing		fabric & craft stores	
sewing needles		fabric & craft stores	• needles with big eyes will be easy to thread (look for "crewel" or "embroidery" needles) • needles must be slender enough to sew through the holes of the battery holders

[1] http://www.digikey.com - lowest prices, difficult to navigate
[2] http://www.sparkfun.com - slightly higher prices, easier to navigate

Identifying Polarity

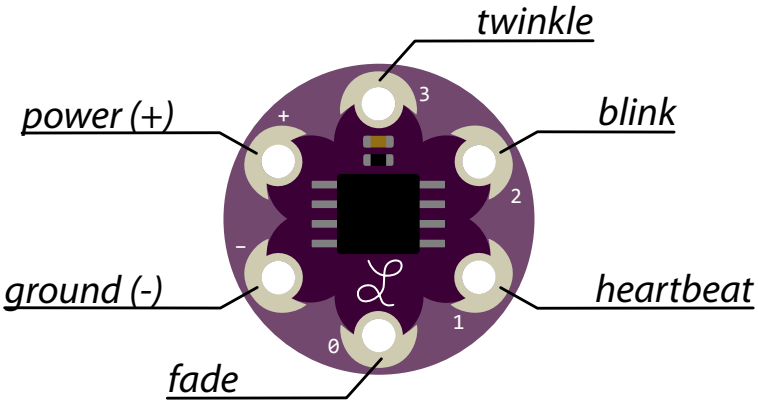
battery holder

LED

LilyTiny Diagram

A microcontroller is like a miniature computer. It will act as the "brain" of a circuit.

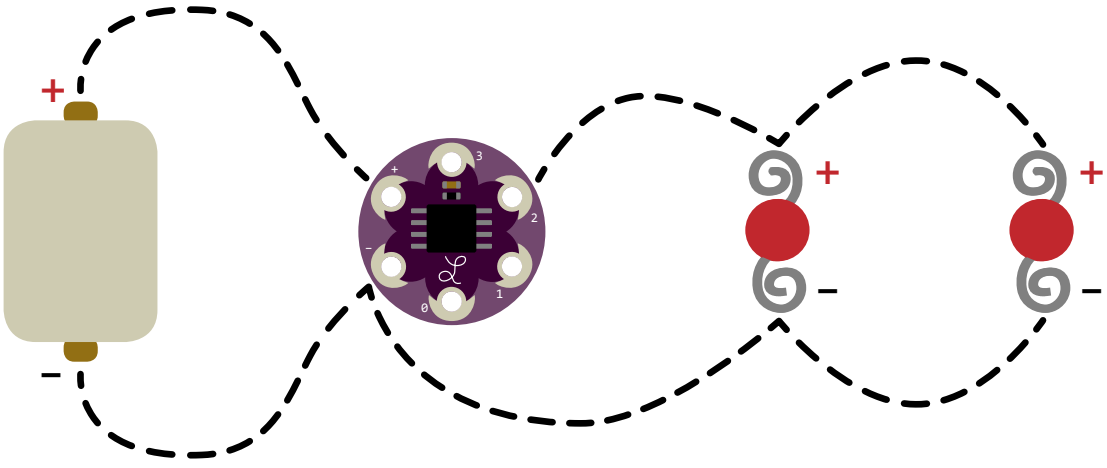
Each LilyTiny contains a microcontroller that has been pre-loaded with a program. The program can control the behavior of connected LED lights, causing them to blink, fade, twinkle, or pulse like a heartbeat.



An Example Circuit

The positive side of the LED should be connected to a numbered pin on the LilyTiny, and the negative side of the LED should be connected to the – pin on the LilyTiny. The + and – pins of the LilyTiny should be connected to the positive and negative sides of the battery holder.

If you place multiple lights into your circuit in parallel *(as in this diagram), these lights will perform the same behavior. Connecting the positive sides of different lights to different numbered LilyTiny pins will result in each light performing a different behavior.*



In this example, both LEDs will blink because they are both connected to Pin 2.

Monster Templates