1/Sensors

Sensors surround you in daily life. The world is full of them: from passive infrared sensors in motion detectors, to CO_2 detectors in air conditioning systems, and even tiny accelerometers, GPS modules, and cameras inside your smartphone and tablet—sensors are everywhere! The variety of sensor applications is remarkable.

It's safe to assume that if an electronic device is considered "smart," it's full of sensors (Figure 1-1). In fact, thanks to the proliferation of smart devices, especially phones, the price of sensors has been driven to affordability. Not only is it economically viable to add advanced sensors to your projects, but they vastly expand the kinds of projects you can make.

You'll learn about sensors in this book by making small projects and reflecting on the experience. It's more fun to build first and discuss later, but both are equally important. It's best to avoid the temptation to only build projects and skip the conceptual sections.

Getting started with sensors is easy, and only the sky is the limit. Electronics challenge some of the best brains daily and produce new innovations and dissertations. On the other hand, even a child can get started with some guidance.

If you don't know much about sensors yet, try to remember what it feels like now. After you've tackled some challenges and built a couple of gadgets, many dark mysteries of sensors will probably seem like common sense to you.

This book is suitable for anyone with an interest in sensors (see Figure 1-2). After you've built the gadgets and have read this book, you can get ideas for bigger projects from our book *Make: Arduino Bots and Gadgets* or learn more advanced sensors in *Make: Sensors*. For a wider view of the basics, see *Getting Started with Arduino, 2nd Edition* by Massimo Banzi, *Getting Started with Raspberry Pi* by Matt Richardson and Shawn Wallace, or *Make: Electronics* by Charles Platt.

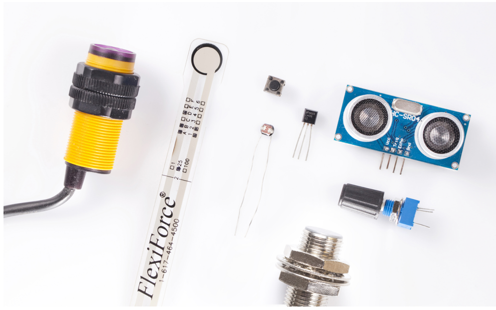

Figure 1-1. *Various sensors: infrared proximity, rotation, brightness, button, temperature, and distance*

What are sensors? Sensors are electrical components that function as input devices. Not all inputs are explicitly sensors, but almost all inputs use sensors! Consider your computer mouse or trackpad, a keyboard, or even a webcam; these are not sensors, but they definitely use sensors in their design. More abstractly, you can frame sensors as a component to measure a stimulus that is external to the system it is in (its environment). The output data is based on the measurement. For example, when you type at a keyboard, the letter that appears on your screen (the output) is based on the measurement (which switch, or key, you pressed on the keyboard). How many letters appear on screen is based on another measurement (how long you keep the key pressed).

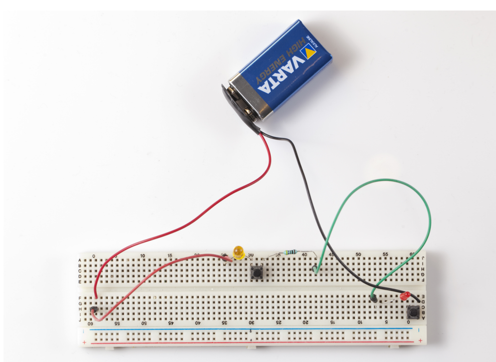

Figure 1-2. *Simple AND connection with buttons, built and designed by a four-year-old with help from an adult*

The first project uses a photoresistor to measure light. Without the photoresistor (or similar sensor), there is no way the circuit can know how bright the light is in the environment. By adding the sensor, your circuit knows something it didn't know before.

All of the projects in this book *evaluate* a particular stimulus within the environment. None of this would be possible without sensors. Let's get building so you can experience the inputs and outputs that sensors provide to projects.

Project 1: Photoresistor to Measure Light

Light in an environment is quite informative: you can determine what time of day it is based on the sun's angle, you operate a car more safely at night when its lights are on, and people who do not experience enough light in daily life can become depressed with seasonal affective disorder. As such, light influences many aspects of your life and it's fun to measure it, too.

The simplest sensor for detecting light is a *photoresistor*. It's not uncommon to also encounter another name for the exact same sensor: *light-dependent resistor* (LDR). The component works by changing its resistance based on the amount of light hitting it.

Now that you know the right sensor to use, the next question to think about is how to process the sensor's measurements. If you've ever worked with a light-emitting diode (LED) , shown in Figure 1-3, you might know that resistance is an electrically important consideration. For example, if you've ever used a larger-value resistor for the LED than a project called for, you've seen that too much resistance can restrict an LED from illuminating. This same basic observation is applicable to this project.

Figure 1-3. *LEDs*

The circuit is designed so that an LED is dependent on the photoresistor's measurement. Too much resistance and the LED simply will not turn on. Enough discussion—it's time to build! Figure 1-4 shows the finished project.

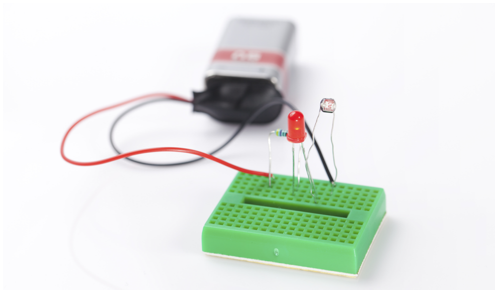

Figure 1-4. *The finished photoresistor project*

Parts

You need the following parts for this project:

- Photoresistor
- 5 mm red LED (different LEDs will work differently with this circuit; later, you'll learn a more sophisticated way to fade LEDs)
- 470 Ω resistor (four-band resistor: yellow-violet-brown; five-band resistor: yellow-violet-black-black; the last band will vary depending on the resistor's tolerance)
- Breadboard
- 9 V battery clip
- 9 V battery

All of these parts, except the 9 V battery and 470 Ω resistor, are available in the Maker Shed Mintronics: Survival Pack, part number MSTIN2. You can use two of the 220 Ω resistors in series or one 1 kΩ resistor in place of the 470 Ω resistor; both of these are available from electronics retailers such as RadioShack.

Build It

Here are the steps for building this project:

1. Orient your breadboard so that it is wider than it is tall, as shown in Figure 1-5.

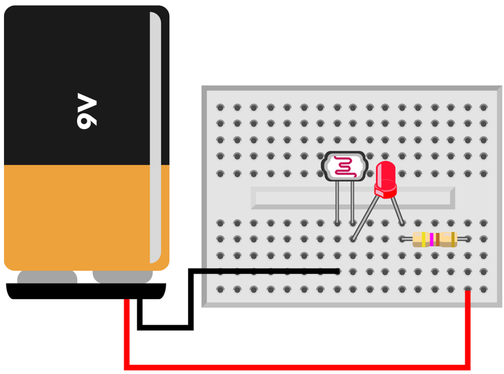

Figure 1-5. *Circuit digram for photoresistor project*

2. Look at your LED and determine which lead has a flat side above it on the colored plastic housing—this indicates the negative lead of the LED (the negative lead is also the shorter of the two), as shown in Figure 1-6. LEDs have a certain *polarity* and putting them in backward might damage them.

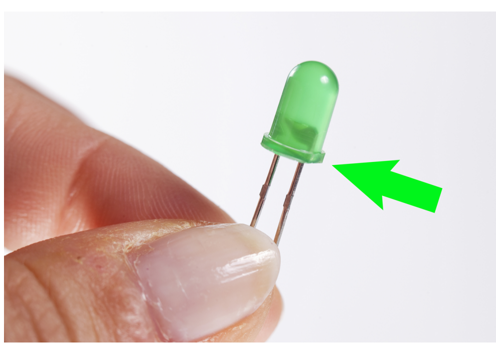

Figure 1-6. *Negative leg of the LED*

3. Insert the photoresistor so that the negative lead of the LED and one of the photoresistor leads occupy the same column. The second (positive)