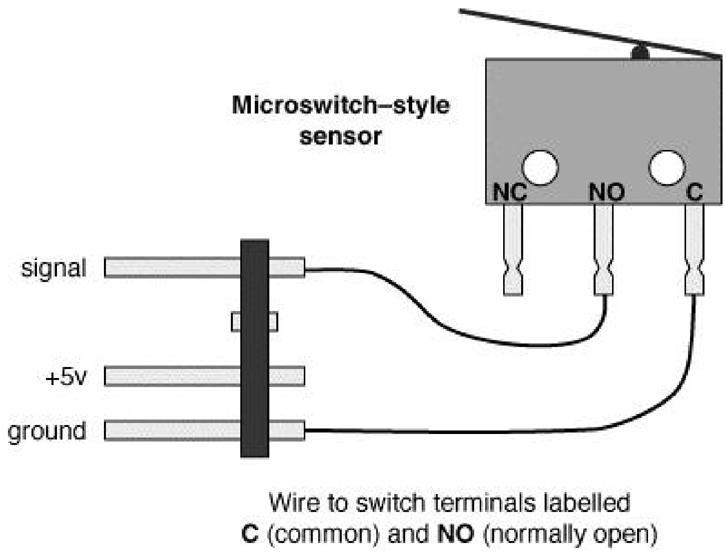
Robotic Design Studio
Sensor Summary

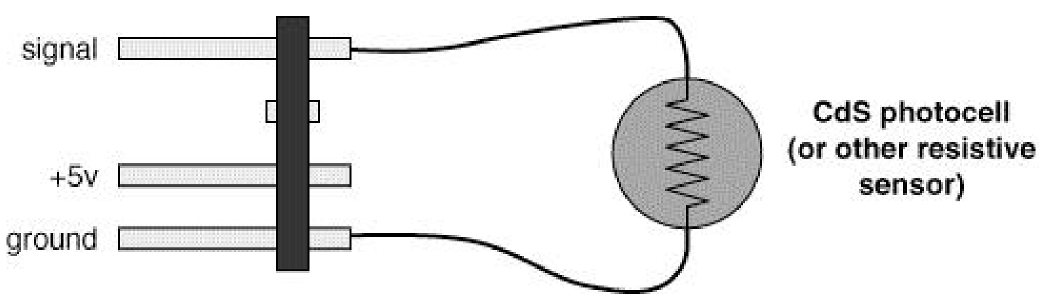
As you think about possible projects it is helpful to know what sorts of sensors are available for the robots and what their capabilities and limitations are. Here's a short catalogue of the sensors that are currently available or under development, along with a brief description of what they do and some suggestions about what they might be useful for.

Touch Sensors



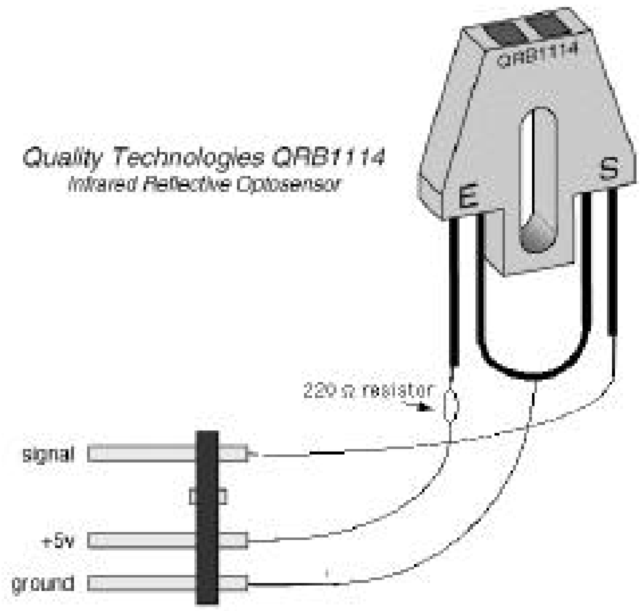
Perhaps the most commonly used of all robotic sensors, the "touch sensor" is nothing more than a simple electrical switch; when the lever is pressed an electrical circuit is completed. Touch sensors were used in making *Sciborg's* bumpers. *Chimera* used touch sensors in its head (to tell when it was being petted) and its tail (to tell when it was being pulled.) Touch sensors are also useful as "limit switches", to indicate when some mechanism has reached the end of its travel.

Light Sensors



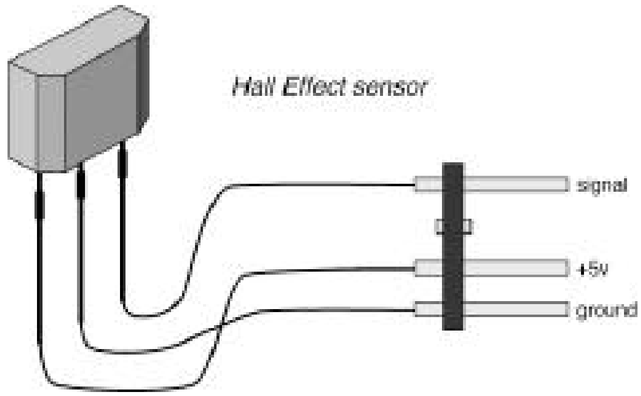
The light sensors we use are made using a **photocell**, which is made a substance whose electrical resistance decreases when it is illuminated with visible light. As you've probably noticed, in Handy Logo the sensor values get smaller as the intensity of light increases. (We'll explain why next week.) *Sciborg* has a pair of light sensors in front, which can serve as eyes. (With a relatively simple program you can make *Sciborg* follow a flashlight.) The *Tag Playing Robots* used light sensors to see each other. To accomplish this they employed a useful trick: an opaque tube is attached to act as a "blinder", allowing the sensor to look in one particular direction at a time.

Reflectance Sensors



The reflectance sensor consists of two parts: An "emitter", which acts a source of infrared light and a "detector" that measures the amount of infrared light entering it. You can't see the infrared light produced by the emitter (unless you are a bumblebee), but next week we'll use a video camera to prove to you that it's there. Because the emitter and detector are mounted side by side the detector responds mainly to infrared light that has originated from the emitter and has been reflected into the detector by a nearby object. (The detector is covered with a filter that blocks out visible light, making it less sensitive to room light.) As you've seen in the *Sciborgs*, reflectance sensors are good at distinguishing whether a nearby object is black or white and are therefore useful in line following and other creature navigation. They are also useful in "seeing" nearby objects: *The Egg Eating Praying Mantis* used one to see the egg, *Amazing Mouse* used reflectance sensors to see the walls of the maze, *Xylophone Player* used a reflectance sensor to see where the xylophone keys were, *Bumphries the Bombastic Bridge Layer* used one to see where the table ended, and *Handroid* used reflectance sensors one each of its fingers to see the keyboard keys.

Magnet Sensors



The Hall Effect sensor detects the presence of a magnetic field, yielding a true or false output. The devices typically "latch onto" the last magnetic pole detected; *e.g*., north pole yields a logic one and south pole yields a logic zero. Hall Effect sensors are good for building "shaft encoders", devices that can count the revolutions of a rapidly spinning wheel. If a small magnet is mounted a on a wheel that rotates by the sensor, the sensor will register one transition each time the magnet swings by. (This is the way bicycle speedometers are built.) When mounted somewhere on the gear train of a moving creature, shaft encoders built with magnet sensors can be used to precisely monitor the distance the creature has moved.

Temperature Sensors

These are built using **thermistors,** materials whose electrical resistance changes with temperature. The thermistors we have decrease in electrical resistance as the temperature increases. This means that the Handy Logo sensor values go down as the temperature increases. We've noticed that these temperature sensors respond differently to different people: Hold one in your finger tips and you can tell how hot you are!

The following sensors are available for the Crickets; with a little bit of soldering they can be adapted to the Handy Boards.

Clap Sensors

Developed by Laura Wollstadt '98 as a 350 project, these sensors use a microphone and some clever circuitry to respond to a clap or other loud sound. *Row-bot* used a clap sensor as a trigger to start rowing.

Bend Sensors and "Skin" Sensors

The bend sensors are a long strip of flexible plastic whose electrical resistance changes as it is bent. They were originally developed by the Nintendo Corp. for a device they sold called the Power Glove. Bend sensors were sewn into the fingers of the glove, enabling wearers to control action in a video game by flexing their fingers. *Venus Fly Trap* used bend sensors to simulate the filaments of a flower. When a bug was sensed wiggling the filaments, *Fly Trap* would close its mighty jaws. We also have a sample of a "skin sensor" material, which is similar to the bend sensor, but respond more to gentle stroking than to bending.

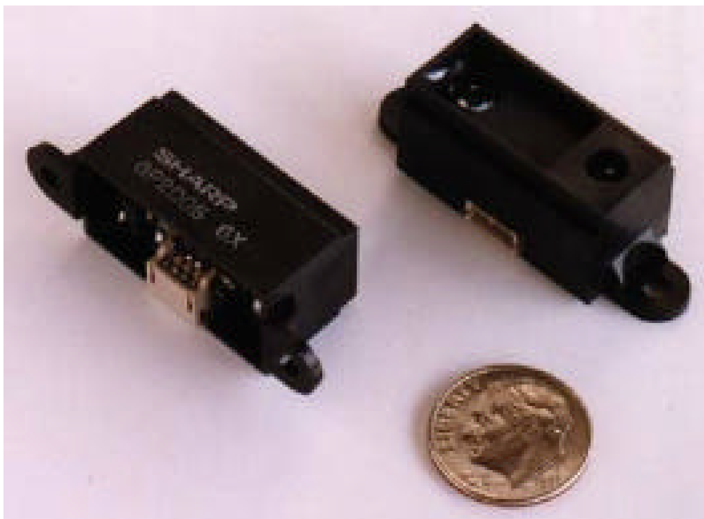
Altimeter

Built by Wellesley student Jelena Madic, the altimeter can sense changes in elevation as small as 2 meters.

Heart Monitors

The Heart Monitors are of the type used by athletes to monitor their heart rate. They consist of a belt worn around the chest and a small box of electronics that plugs into the Cricket or Handy Board. When the belt wearer is within about 1 meter of the box, the Handy Board will be able to detect each time her heart beats. You might want to build a robot that responds to your beating heart!

Infra-red Position Sensor (Bathroom Sensor)



Ever wonder how the sinks in some public rest rooms know to turn on the water when you put your hands under the faucet? Or how a toilet knows to flush itself when you walk away from it? These feats are accomplished using a clever variation of an infra-red reflectance sensor. Like the reflectance sensors these sensors emit a beam of infra-red like and then detect portions of this beam that have been reflected by a nearby object. The new twist is that the detector uses a lens to image this reflected light onto a position sensitive detector. Because of a “parallax effect”, the position of the image will depend on the distance from the reflective object to the sensor. The device is capable of reading distances of nearby objects (they can be anywhere from 4 cm to 80 cm away) with a precision of about 0.5 cm. Very impressive. We have a version of this sensor that works with the Crickets. Now your robot can be at least as smart as a public bathroom!