

# Sensors For Robotics

Robotics Academy 2002. All Rights Reserved.

## What makes a machine a robot?

Robotics Academy 2002. All Rights Reserved.

## What is sensing?

**Sensing** is converting a quantity that you want to measure into a useable signal (usually electronic).

**Perception** is the interpretation or understanding of these signals.

**Example:**  
**Sensing:** Sound waves -> vibrating eardrums -> signals to brain  
**Perception:** Understanding that I am talking to you about sensors.

Robotics Academy 2002. All Rights Reserved.

## Why do robots need sensors?

**What is the angle of my arm?**

**internal information**

Robotics Academy 2002. All Rights Reserved.

## Why do robots need sensors?

**Where am I?**

**localization**

Robotics Academy 2002. All Rights Reserved.

## Why do robots need sensors?

**Will I hit anything?**

**obstacle detection**

Robotics Academy 2002. All Rights Reserved.

### Sensing for specific tasks

**Where is the cropline?**



**Autonomous harvesting**

Robotics Academy 2002. All Rights Reserved.

### Sensing for specific tasks

**Where are the forkholes?**



**Autonomous material handling**

Robotics Academy 2002. All Rights Reserved.

### Sensing for specific tasks

**Where is the face?**



**Face detection & tracking**

Robotics Academy 2002. All Rights Reserved.

### Common Sensors in Robotics



Rotation sensors (also called encoders) measure the rotation of a shaft or axle. They are used to measure the angle of a robotic arm, or how far a mobile robot's wheel has turned.

Global Positioning Systems (GPS) receive signals from orbiting satellites that pinpoint the location of an outdoor robot on the Earth.



Robotics Academy 2002. All Rights Reserved.

### Common Sensors in Robotics



Laser range finders use laser beams to measure the distance to objects. They are used for obstacle detection and navigation.

Cameras are a very common sensor. **Computer Vision** is the field of study of interpreting camera images for a variety of purposes.



Robotics Academy 2002. All Rights Reserved.

### Lego Sensors

We will be using 3 types of Lego sensors.



Touch sensor

Light sensor

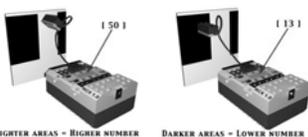
Rotation sensor

Robotics Academy 2002. All Rights Reserved.

## Light Sensor



Measures the level of light as a number between 0% (total darkness) and 100% (very bright).



BRIGHTER AREAS = HIGHER NUMBER  
DARKER AREAS = LOWER NUMBER

Can differentiate light levels reflected from bright and dark surfaces.

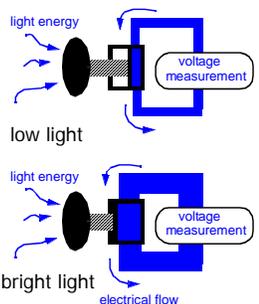
Robotics Academy 2002. All Rights Reserved.

## Light Sensor



Inside the light sensor is a **photo-transistor**.

The photo-transistor acts like a valve for electricity. The more light energy it senses, the more electricity flows.



Robotics Academy 2002. All Rights Reserved.

## Light Sensor

**Uses:**

- ☐ Navigation - follow a black line on a white surface (or vice versa).
- ☐ FireflyBot - find a very bright object in a room or area (light bulb).
- ☐ Color sorter - tell the difference between black Lego bricks and yellow Lego bricks.
- ☐ Input Device - different colors or gray levels on a piece of paper.

Robotics Academy 2002. All Rights Reserved.

## Touch Sensor

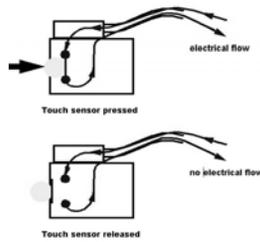
**Uses:**

- ☐ Detect contact between the robot and external objects like walls.
- ☐ Detect contact with internal moving parts in the robot (arm or gripper).
- ☐ TableBot - detect contact with the ground so the robot doesn't fall off the table.
- ☐ Input Device - push button or "remote" control.

Robotics Academy 2002. All Rights Reserved.

## HOW DOES A TOUCH SENSOR WORK?

- ⌘ A touch sensor works like a light switch in your house.
- ⌘ When the button is pressed, an electrical circuit is closed inside the sensor. This lets electricity flow.
- ⌘ When the button is released, the circuit is broken and no electricity flows.
- ⌘ The RCX can sense this flow of electricity, so it knows if the touch sensor is pressed or released.



Robotics Academy 2002. All Rights Reserved.

## Connections

- ⌘ It is important to connect the cable to the touch sensor in the correct way.
- ⌘ Which one of these is right?



Robotics Academy 2002. All Rights Reserved.

### HOW DO I PROGRAM A TOUCH SENSOR?

- ⌘ Touch sensors are programmed to detect when their buttons have been pushed in or released.
- ⌘ You need to specify which sensor port a touch sensor is connected to.
- ⌘ This icon causes the program to wait forever until the touch sensor on port 1 has been pushed in.



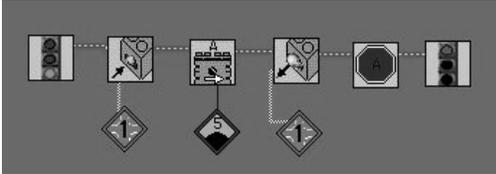
Robotics Academy 2002. All Rights Reserved.

- ⌘ This icon waits until the touch sensor has been released.



Robotics Academy 2002. All Rights Reserved.

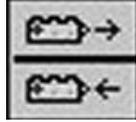
- ⌘ Touch sensors can be used to control the motors.
- ⌘ This program waits forever until the touch sensor has been pushed in.
- ⌘ When this happens, motor A is commanded to turn on.
- ⌘ Motor A continues to run until the touch sensor has been released, and motor A is commanded to stop.



Robotics Academy 2002. All Rights Reserved.

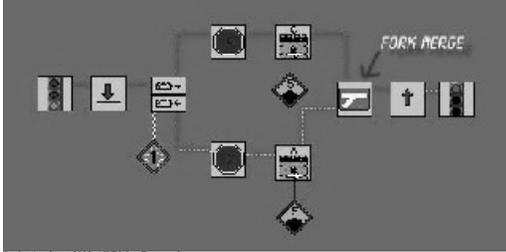
### Touch sensor forks (more advanced)

- ⌘ The touch sensor fork can be used to have the program do different things depending on if the touch sensor is pushed in or released.



Robotics Academy 2002. All Rights Reserved.

- ⌘ In this program, if the touch sensor is pushed in, then motor A is turned on and motor C is commanded to stop.
- ⌘ If the touch sensor is released, then motor C is turned on and motor A is stopped.
- ⌘ Remember that a fork statement needs a fork merge at the end of the decision.

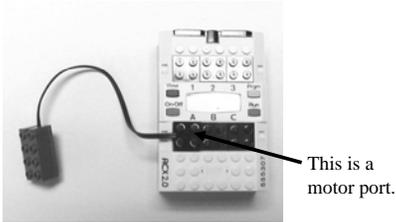


Robotics Academy 2002. All Rights Reserved.

### Lesson 3: Sensor Wait-for's Troubleshooting Tips

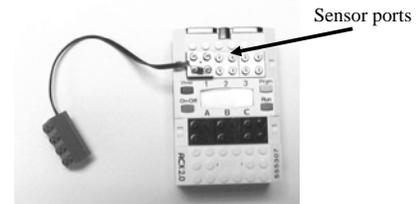
### Problem 3a

Why won't the light sensor work?



### Solution 3a

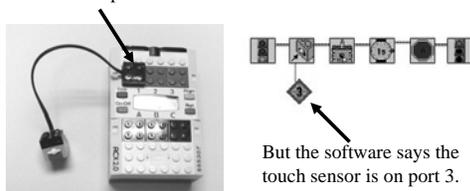
Sensors need to be connected to Sensor ports 1, 2 or 3.



### Problem 3b

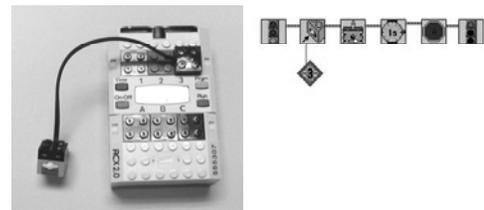
What's wrong with this set up?

The touch sensor is connected to port 1.



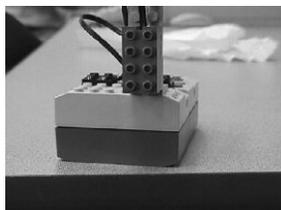
### Solution 3b

⌘ Connect the touch sensor to port 3.  
⌘ Or, change the port number in the software.



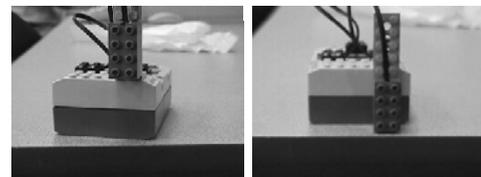
### Problem 3d

What isn't too great about the way the light sensor is mounted?



### Solution 3d

If the light sensor is too high, it has a harder time distinguishing between black and white. Mounting it lower to the ground will help.



## Work Cited

- ⌘ Most of this from Carnegie Mellon University, Robots Academy (open source)  
<http://www.rec.ri.cmu.edu/education/content/products/index.html>  
(12/7/2004)
- ⌘ Format and layout changed to fit Power Point.

Robotics Academy 2002. All Rights Reserved.