



MARS ROBOTICS EDUCATION POSTER

<http://mars.jpl.nasa.gov/classroom>

Activity #2: Rover Parts - Sensors, Actuators, & Processors

Grade Levels:	5 - 12
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Time Frame:	15 - 20 minutes
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Background:

This activity introduces two of the three major components that go into every robot: sensors for determining its environment and actuators for affecting its environment. Students will be presented with real-world robots and asked to identify what parts are sensors and what parts are actuators. This activity also serves to expose students to the way in which robots are being used in our daily lives -- they may be surprised to learn just how common robots really are!

Sensors are what the robot uses to gather data about the world around it. Cameras and touch sensors are very common, but some robots use temperature, humidity, or even pH sensors. The smoke detector installed in your home uses a carbon-monoxide sensor to determine if there is a fire in the house. Some sensors are a bit more mundane, but no less important. The switch that controls your refrigerator light, mounted in the door, is a sensor that detects the state of the door (open or closed). A sensor, by itself, does nothing but provide data. It is up to other parts of the robot to actually do something with that data.

Actuators are what the robot uses to affect the world around it. An actuator may be a motor that moves a robotic arm, wheels that move the robot across a surface, or something as simple as a light that the robot can turn on for illumination or to signal its controller. In a smoke detector, the alarm is an actuator. In your refrigerator, the interior light is an actuator. Anything that allows the robot to make a change in its environment falls into this category. In a sense, actuators provide the output that results from the input provided by the sensors.

Most robots have a third component: a **processor** that is able to take input from the sensors, make decisions based upon that input, and control its actuators to respond to those decisions. Some robots have processors that are not this complex -- they can only perform a pre-determined set of instructions (or a single instruction) over and over. For example, both the smoke alarm and the refrigerator have a single instruction they can follow. When the smoke alarm's sensors tell the processor that they detect smoke, it sounds the alarm. When the refrigerator's switch tells the processor (a simple circuit, in this case) that the door is open, it turns on the light. Some robots, such as NASA's

Mars exploration spacecraft, have very sophisticated processors that are able to take in data from a wide variety of sensors and make intelligent decisions based on that data. Students will gain more experience with robot processors in *Mars Robotics Poster Activity #8: Rover Races*.

Learning Goals:

Students will learn to identify the critical components that go into constructing a robot.

National Science Education Standards

Content Standard E: Understandings about Science and Technology

Materials Needed:

- Mars Exploration Rover diagram
- Robot pictures
- Student Activity Sheet and Picture (one per team of 4 students)

Optional Materials:

- None

Procedure:

This activity is very straightforward. Begin the discussion by describing sensors and actuators and the difference between them (sensors take in information from the environment, actuators act upon the environment). Show the students the diagram of NASA's Mars Exploration Rover and have them decide whether each of the listed parts is a sensor or an actuator.

When your students have the basic idea of "sensors = input, actuators = output," display photos of various machines and robots (several are included with this activity on pages 6-8). Ask the students to identify the sensors and actuators in each device. Finally, ask your students to look around the room and identify devices that have sensors and actuators and discuss the role each part plays in the device. As a check of the students' understanding, give them the photo of the refrigerator and have them identify all the sensors and actuators they can!

Assessment:

When presented with a picture of a robot, or with the device itself, students should be able to identify the sensors and actuators in the device and what role those parts play.

Vocabulary:

- Sensor
- Actuator
- Processor

Age-Level Adaptations/Extensions:

Younger students, being concrete operations thinkers, may need to see the physical devices rather than pictures in order to gain a complete understanding of the concepts. (You should be aware that most smoke detectors have a small radioactive chip installed in them. While this chip is harmless, some parents may object to having the physical smoke detector available for close inspection. We leave that decision to you!)

Older students should be able to discuss devices outside of the classroom that have sensors and actuators. Encourage them to think of examples from their own experience.

“High-Tech” Adaptations/Extensions:

Use a commercial computerized robotics kit to construct an actual robot. Discuss with your students what each sensor and actuator does. Have your students characterize the components by describing what types of input each sensor can take as well as how sensitive it is. Have the students describe the power output of the different motors, as well as how fine a control can be achieved with them.

Credits:

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Answer Key for Robot Pictures

Page 1:

Smoke Alarm

Sensors: Carbon-monoxide-level detector, battery-voltage detector
Actuators: Alarm

Night light

Sensors: Light-level detector
Actuators: Light

Page 2:

Stove

Sensors: Temperature sensor
Actuators: Heating elements

Garage door opener

Sensors: Radio-command receiver
Actuators: Door-opening motor, garage light bulb

Page 3:

Thermostat

Sensors: Temperature sensor
Actuators: Heating/air-conditioning controller

Toaster

Sensors: Temperature sensor
Actuators: Heating elements, spring lifter

Pages 4 and 5 (Student Photo and Questions):

Refrigerator

Sensors: "Door open" switch, temperature sensor, ice-level sensor (in ice maker), frost-level sensor
Actuator: Condenser motor, ice-maker motor, interior light

Name: _____

Robot Anatomy 101: Sensors, Actuators, and Processors

Take a close look at the picture of the refrigerator (or think of your refrigerator at home). In the space below, list the sensors and actuators you can identify in this robot?

Sensors:

Actuators:



Smoke Alarm



Night Light



Stove



Garage Door Opener



Thermostat



Toaster



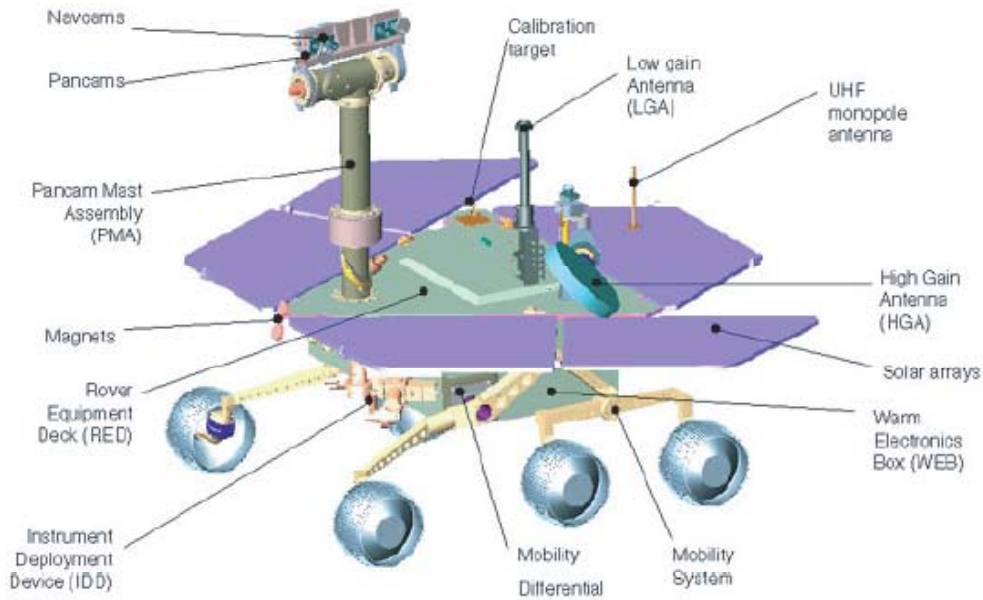
Refrigerator



MER Rover Configuration - Deployed



Mars Exploration Rover



AAS National Conference
November 2001 (Cleared for External Release - #01-2451)

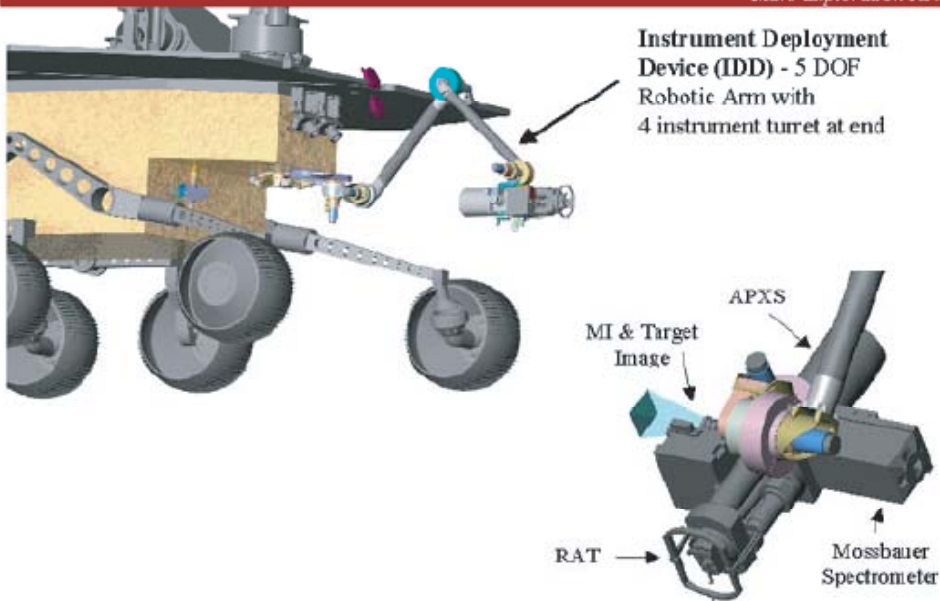
MER - 1



MER-Instrument Deployment Device



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MER - 2

Rover Parts