9-12 Activity #1

Astronauts Little Helpers Article:

In the near future, an astronaut may be awakened in the morning by a personal assistant that will provide a briefing for the coming day. There are computer files to check, experiments to monitor, inventories to update, web sites to consult, reports to file and for each task, the astronaut's assistant keeps track of progress, notes unusual circumstances, and provides feedback. The assistant also keeps a log of conditions on the Space Shuttle or Space Station. For example, if levels of oxygen, hydrogen, or emissions reach critical levels, the assistant lets everyone know. The assistant can also help when a videoconference is needed by providing the hookup and transmission requirements.

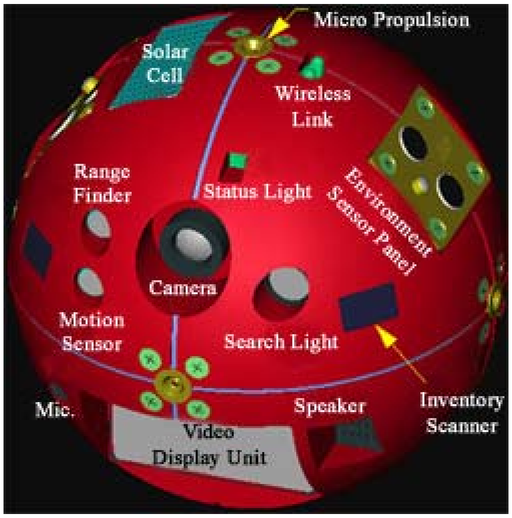
That's a mighty busy assistant! The surprising part is that this assistant isn't a human; it's a robot. To most people, however, this robot doesn't look like anything they might expect. Not at all humanoid, this robot looks like a large, red, flying grapefruit. It's packed full of sensors, miniaturized video equipment, wireless network equipment, and technology that allows the robot to understand spoken commands and reply with the same.

"We're developing an intelligent robot that essentially can serve as extra eyes, ears, and nose for the crew and ground support personnel," says Yuri Gawdiak, principal researcher for the Personal Satellite Assistant (PSA) in development at NASA's Ames Research Center in California. "The PSA will allow scientists to interact naturally with the crew. Because it's not a humanoid shape, it will offer more **dexterity** and enhanced performance because it can travel where people can't." **Prototypes** are being developed; a test flight is planned for mid-2002, and a year later, the PSA could be on the job up in space.

Developing the PSA has presented scientists with enormous challenges. PSA will operate in microgravity conditions, and it's difficult to simulate those settings here on Earth. "There will be lower power requirements up in space for the robot to move," says Gawdiak. "On the Space Station, it takes far less effort and much reduced power requirements."

The PSA is eerily close to the flying **bot** that taught Luke Skywalker to fight with a light saber in *Star Wars*. It floats in microgravity, and propels itself by using small fans. PSA maneuvers tight corners records actions on video, and can go where humans can't—to check on a potentially hazardous situation, for instance. Several PSAs could be used to locate environmental problems such as pressure leaks, temperature spikes, and gas emissions. Besides alerting astronauts to dangerous situations, the PSA can also take care of tedious tasks ranging from inventory control to monitoring experiments to taking the night **sentry** shift.

The PSA can transfer data between the spacecraft's main computers and those on the ground at mission control. PSA can receive programmed instructions and be modified as needed. PSA can serve as a video outlet for communicating between Earth and space. And because it's so personally programmable, PSA will be able to learn how each user wants to be



assisted, Gawdiak says. "PSA will learn whether you want it to fly beside you or behind you. It will learn your schedule, get you the updates you want from the ground, and interact with you on a highly personal scale. It won't just be mobile; it will understand much of what you want it to do."

The PSA serves four main functions:

1. Environmental monitoring: The PSA patrols astronaut living quarters and laboratories to monitor oxygen, nitrogen, carbon dioxide, and other gas levels. PSA can also monitor experimental data such as microgravity levels, temperature, and atmospheric pressure.

2. Communications links: PSA functions as a remote, mobile data display terminal for system and experimental data. PSA has communication input and output capabilities, including a microphone, speakers, a camera, and a display panel. These features allow for audio conferencing, videoconferencing, and a wireless relay to link other communication systems.

3. Remote operations support: Ground controllers are able to communicate with the PSA and maneuver the device into the desired location. Once in position, the PSA can use its sensors to monitor the status of experiments or to provide ground controllers with remote views of mission operations.

4. Crew worksite support: The PSA provides astronauts onsite access to information such as vehicle status and crew health data, mission schedule, inventory tracking, location information, and training support. PSA also has the ability to provide updates and alarms related to system events, payload events, or mission experiments.

"Operations we take for granted are very hard to program into a robot," Gawdiak says. "Something as basic as deciding where and when to go to a location, and how to react to variables that might come up along the way are enormously complex programs. The technology that has come about to create the PSA is directly transferable to Earth. In any system—a subway or a factory, for instance—robots can be assigned the mundane and dangerous situations, rather than humans. Managing inventory, monitoring hazards, and performing security can be done by robots to spare humans the risk."

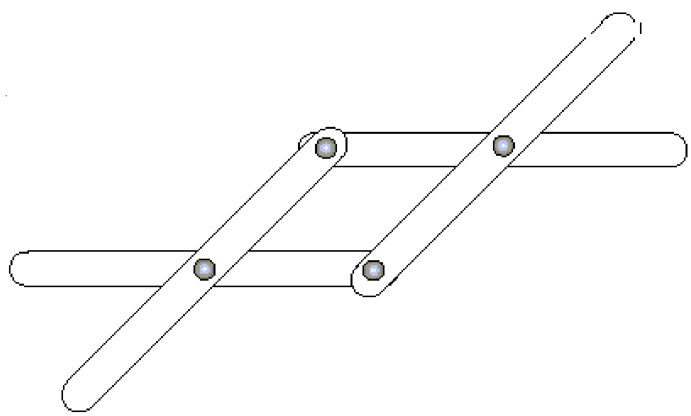
Robotic Arm

Teacher Sheet(s)

Objective:	To develop a robotic arm and an end effector to interact with the environment.
Level:	9-12
Subjects(s):	Space Science, Physical Science, Technology
Prep Time:	Less than 10 minutes
Duration:	50 minutes
Materials Category:	General Classroom

Materials:

- Wooden craft sticks
- Drill
- Small brass paper fastener
- Assorted small materials



Related Links:

[Let's Talk Robotics - Video Resource Guide - EV-1998-04-015-HQ]

[NASA Rover Ranch]

Supporting Article(s):

Astronauts' Little Helpers

Pre-Lesson Instructions:

Optional: Order a copy of the NASA video "Let's Talk Robotics" from NASA CORE

Video Synopsis

Length/Year	14 minutes/1998
Format	1/2" VHS
Item Number	011.0-04V
Price	$10.00

Description:
This video program examines some of NASA's robotic research and how robots are used in space exploration In this video, several of NASA's robotic applications are explored. Viewers will learn about the Pathfinder robot that landed on Mars in 1997 and released a microrover spacecraft (Sojourner) to explore the nearby Marscape. Viewers will also learn about the 15 meter-long Remote Manipulator System arm that Space Shuttle astronauts use to handle payloads in space and to assist in space construction and satellite repair operations. Research being done to test robotic arms for the International Space Station and a free-flying camera robot will also be seen.

Note: This lesson can be completed with or without the video. The video is a great introduction to the topic of robotics.

Background Information:

None

Guidelines:

1. Read the 9-12 article, "Astronauts' Little Helpers." Discuss the use of robotics in movies and in everyday life.

2. Provide time for students to brainstorm and modify their robotic arms.

3. Each student or group of students will need a minimum of four craft sticks and four brass fasteners.

Discussion/Wrap-up:

None

Extensions:

- Complete Lesson 2 under 9-12 article, "Astronauts' Little Helpers."

- Explore K-12 Experiments in Robotic Software at the NASA Rover Ranch.

Robotic Arm

Student Sheet(s)

Materials

- Wooden craft sticks
- Drill
- Small brass paper fastener
- Assorted small materials

Background Information

The word robot comes from the Czech word robota that means forced or repetitive labor. Czech playwright Karel Capek coined the term for his 1920 play R.U.R. (Rossum's Universal Robots). In the play, the human-like robots take over the world.

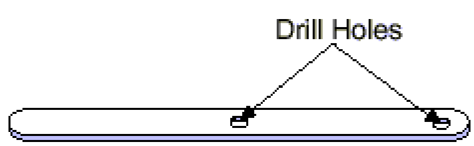
Today's robots usually look very different from humans. They are found in manufacturing, research, medical treatment, entertainment, and space. NASA uses robots to explore Earth and the other planets and to manipulate payloads on the Space Shuttle, and plans to use several robotic arms on the International Space Station.

The definition of what a robot is varies with the source referenced. Generally, robots are machines that operate by computer controls. On Earth, robots are often used for dangerous, dirty, or dull jobs. Examples include painting and welding robots in automotive assembly lines and robots used to dismantle old nuclear power plants. In NASA-sponsored experiments, walking robots were used to explore active volcanoes in Alaska and the Antarctic.

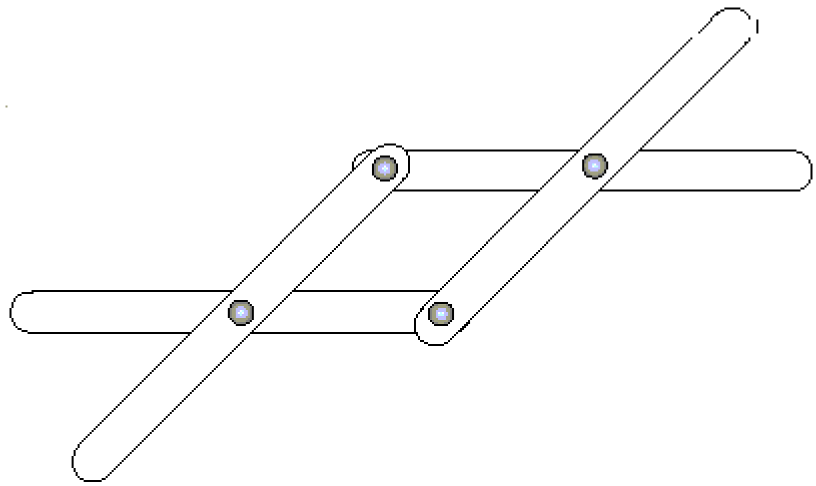
One of the important objectives in the development of robots is to enable robots to interact with their environment. Interaction is often accomplished with some sort of arm and gripping device or end effector.

Procedure

1. Define the following terms:
    - Articulated
    - End effector
    - Telerobotics
2. Drill holes through the craft sticks as shown in the diagram.



3. Each student will need four drilled sticks and four brass paper fasteners. Note: dampening the sticks before drilling can reduce cracking the wood.
4. Assemble robotic arms as shown in the illustration below.



5. Try to pick up a pencil or some other object with the arm.
6. Next, design some sort of end effector for the end of the arm that will enable you to pick up different objects.
7. Attach the effector to the ends of the arm with glue.
8. Write a paragraph evaluating your design by picking up different objects.
9. Would the arm and end effector have to be modified to pick up sediment and pebbles on Mars?

9-12 Activity #2

Supporting Article: Astronauts' Little Helper

Robotic Maze

Teacher Sheet(s)

Objective:	To develop a robotic arm and an end effector to interact with the environment.
Level:	9-12
Subjects(s):	Space Science, Physical Science, Technology
Prep Time:	Less than 10 minutes
Duration:	Two 50-minute class periods
Materials Category:	Special Requirements

Materials:

- Battery-operated toy car
- Masking tape
- Assortment of materials to build a robotic arm
- Assorted small materials to pick up with the robotic arm

Related Links:

Let's Talk Robotics - Video Resource Guide - EV-1998-04-015-HQ

NASA Rover Ranch

Supporting Article(s):

Astronauts' Little Helpers

Pre-Lesson Instructions:

- Optional: Order a copy of the NASA video "Let's Talk Robotics"from NASA CORE.

- Purchase enough battery-operated toy cars for each group of four to have one.

- Introduce the lesson a week prior to building the robotic vehicles. Have students brainstorm how they could build the robotic arm, and have students bring materials for their robotic arms to school.

- Choose a large area to map out the maze.

Background Information:

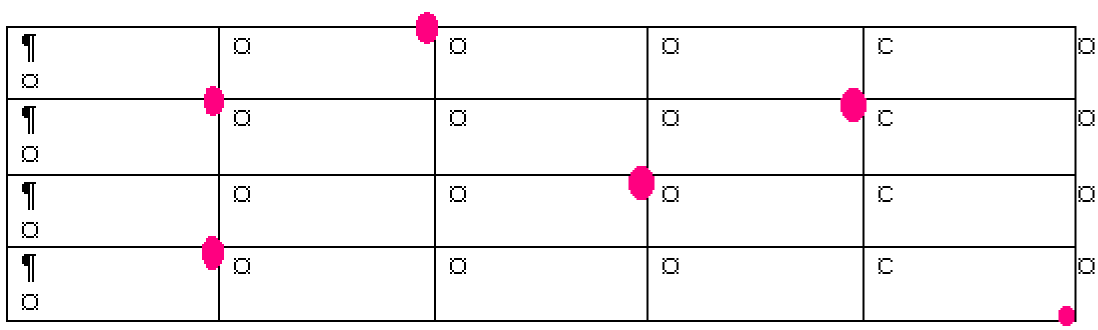
None

Guidelines:

1. Read the 9-12 article, "Astronauts' Little Helpers." Discuss the use of robotics in movies and in everyday life.

2. Provide time for students to brainstorm and modify their robotic arm.

3. Using masking tape, construct a gridline box on the floor based on the following pattern:



4. Place a small object at each circle in the grid the robotic vehicle must pick up.

5. Each team's robotic vehicle must travel only on the gridlines. If a vehicle strays off a gridline, there is a 5-second penalty.

6. Have students graph the number of successful retrievals, and note the time for each.

Discussion/Wrap-up:

None

Extensions:

- Complete Lesson 1 under 9-12 article, "Astronauts' Little Helpers."

- Explore K-12 Experiments in Robotic Software at the NASA Rover Ranch.

- Have students design or build their own rovers, explaining what type of instrumentation they would include and why it is necessary.

- Have students research the history of robotics and create a time line on the wall of the advancements of robots.

Robotic Maze

Student Sheet(s)

Materials

- Battery-operated toy car
- Masking tape
- Assortment of materials to build a robotic arm

Background

By definition, a robot is an electronically controlled device programmed to conduct a series of jobs. The physical appearance of the robot is generally the result of the functions they have been built to perform. Like computers, robots follow commands. Without proper programming, robots can not complete the task at hand.

Procedure

1. Each team will be provided a battery-operated toy car. Each team's goal is to build an arm for the vehicle. A gridline maze will be constructed on the floor. After construction of the robotic arm vehicles, each team will compete to complete and pick up the items in the maze. The team with the most items retrieved in the shortest time is the WINNER.

2. Examine the toy car. Practice operating the remote controlled car, steering the car to the left and right in order to turn corners and reversing the direction of the car. Your car must stay on the gridlines of the maze. Each time the car is off the taped gridline, a 5-second penalty is added to your final score time.

3. Brainstorm as a group about the materials needed to build a robotic arm to attach to the car.

4. Bring in materials. Build and attach the arm to the car. Practice again before the big competition.

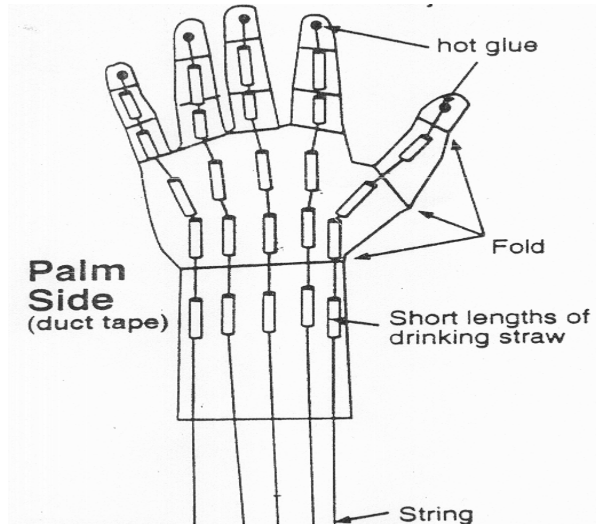
5. For the competition, make a data table of each team's number of items retrieved and the total completion time in seconds.

Conclusion

After the competition, re-evaluate the design of your car. Would you do any modifications? Explain.

9-12 Activity #3

Robot Hand (End Effector)



Materials

- Styrofoam Food Tray (one per student)
- Marker Pens
- Duct Tape
- Scissors
- Glue
- Straws (one per student)
- String (two large rolls)
- Rubber Bands (approx. 3 per student)
- Paint Stick (one per student)
- *Robot Hand (End Effector)* handout (one per student)

Robots are often used to assist humans. In this activity, students will create an end effector designed to replicate the human hand.

1. Remind the students what an end effector is.
2. Announce that they will be creating a rather complex end effector.
3. Pass out the *Robot Hand (End Effector)* handout.
4. Allow the remainder of class for the students to complete the activity.