Advanced Robotics

Educational Goals

Robotics was designed to introduce the science behind the design and operation of robots, and after completing this mission plan Galaxy Explorers will be able to do the following:

- Define a robot as a machine that gathers information about its environment (senses) and uses that information (thinks) to follow instructions to do work (acts).
- Recognize the advantages and limitations of robots by comparing how robots and humans sense, think, and act and by exploring uses of robots in manufacturing, research, and everyday settings.

Discussion:

Hello, my name is _______________. Today we are going to talk about robots; exactly what they are, and what role they play in our lives and in space exploration and development.

A robot is a machine that gathers information about its environment (senses) and uses that information (thinks) to follow instructions to do work (acts).

This is the working definition of robots that we are going to use for our mission. Today technology is changing at incredible rates making the identification of a robot somewhat difficult. Things that we use everyday incorporate features beyond those of early robots. Many things in your home include sensors and/or programmable computer chips that control their operation—for example your programmable VCR, remote car locking systems and furnace thermostat which responds to room temperature and may be programmed to turn the heat down at night and up in the morning. However, robotic engineers would probably not say your VCR or thermostat is a robot.

Today's robots are incorporating multiple sensors and are able to use this information to behave autonomously—making decisions for themselves based on information that they receive.

There is endless variety in the size, shape and jobs of robots. Some robots are used day after day in factories, while others are highly experimental and use artificial intelligence to behave more and more like living creatures, able to act independently in changing environments. Robots are being designed to perform precision surgery, explore space, the ocean, and other dangerous areas.

In hostile environments everywhere, particularly in space, modern explorers are turning to robots to undertake dangerous missions, missions that cannot yet be undertaken by humans. In July 1997, a small robotic rover called Sojourner drove around on the cold surface of Mars, the first of many advanced robots being designed by NASA, European Space Agency, and many countries to explore other planets. On Earth, smart robots are being developed to venture into active volcanoes, fly high in the atmosphere for extended periods of time, dive deep into the oceans, search for land mines left from wars, and help police disarm terrorist bombs.

The space environment is extremely hazardous. It contains intense radiation and extreme temperatures. Planetary bodies have extreme conditions as well including volcanic environments, ice worlds, ocean worlds, and poisonous atmospheres. In fact, space is quite deadly for humans.

It makes sense then that much of space exploration – certainly the earlier phases – should be conducted by robots instead of humans. Add too the fact that it is much cheaper to explore with robots because humans must bring their living environment wherever they go.

In space activities, we use robots in three basic ways: on-orbit assembly, science payload tending, and planetary surface exploration. For example, assembly robots help build the International Space Station. The robots are the eyes and hands of human controllers who will use something called virtual reality telepresence to see what the robot sees.

Sensing
Learn about human and robotic vision systems, explore three modes of robotic sensing, and apply a robotic sensory mode to a specific task.

Thinking
Human thinking (heuristic) and robotic thinking (algorithmic) will be explored as you gain an understanding of why a robot needs specific instructions.

Acting
Use locomotion and manipulation, two primary types of robotic action to understand why sensing and thinking feedback are essential for effective action.

Applications
Discover that robots are capable of planning their own actions. Different situations and tasks will be presented allowing you to explore the advantages of robots in terms of efficiency, accuracy, and safety.

This Mission Plan includes several activities. Mission Team Leaders can use one or all depending on available time and materials.

ACTIVITY: 1

First, gather facts. Look around your home and school for machines, appliances, and other things you use everyday. Are any of them robots? Why or why not?

Can you find the answers to these questions?

What information can robots gather? (Sensing)

What kinds of robots can "see?"

How can robots detect motion?

What does the robot drawing arm look for to be able to draw pictures?

Are there any robots in the exhibit that you think could do a job for you? What would you have them do? (Acting)

How many joints do they have? While looking at and moving your arm, think about the directions that you and the robot can move.

Look at the end effectors or what the robotic arm uses instead of hands. How many different types of end effectors can you find and what types of tasks are they being used to complete?

How would you tell a robot to stop what it was doing and do something else? (Thinking)

Can robots do any jobs better than you?

What can you do better than robots?

Now, solve the mystery by pulling all the facts together and drawing your own conclusion. Have you changed your mind about the robots in your world? For some things it may be difficult to decide if it is a robot or not.

Report back to the Inspector. Give your Mission Team Leader or group leader the answer to the question:

What is a robot?

ACTIVITY: 2

Digital Codes

Background

Computers process information using electrical signals to code and interpret information, and to send control signals.

A binary code is used by computers since a processor is essentially a series of on/off switches or transistors with information either stored or not stored. Information can be transferred using a series of electrical signals—there is electricity flowing or there is no electricity flowing. This causes a motor or a pixel (point of light on a computer screen) to turn on or off or compare the pattern to an image stored in memory.

Materials Needed

graph paper
overhead transparency with graph paper grid
simple pictures

What to Do

To encode sensory information in order to interpret images, computers turn a picture into digital code. To see how this can be accomplished, use a grid to turn a picture into a code of a series of 0's and 1's. Place a transparent grid over a picture. In each square with more than half of the square covered by part of the picture put on one. If there is less than ´ of the picture covered, put a 0 in the square. Read the series of 0's and 1's to another person who will fill in a blank grid to recreate the original picture by reversing the code. (Shading squares when a 1 is read.) Images can be transferred back and forth this way.

After information is encoded, computers can analyze the data in different ways. A mobile robot might look for areas with a sharp contrast in order to follow the edge of a road. A sorting robot might compare a picture in its memory with an object in the camera's view.

A picture of a square translates into the following code:

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	1	1	1	1	1	1	0	0
0	0	1	1	1	1	1	1	0	0
0	0	1	1	1	1	1	1	0	0
0	0	1	1	1	1	1	1	0	0
0	0	1	1	1	1	1	1	0	0
0	0	1	1	1	1	1	1	0	0
0	0	1	1	1	1	1	1	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

ACTIVITY: 3

Moving About

Materials Needed

A variety of construction sets, toy vehicles, remote controlled cars, pictures and/or videos of vehicles and animals moving

What to Do

Look at various pictures or video clips of animals, vehicles and robots. Think about the advantages and disadvantages of various methods of getting around.

Build a variety of vehicles out of construction sets or use remote control vehicles or other toys. Test them on different surfaces. Did some perform better/worse than you expected? Which would you use for speed? Which would you use for rough surfaces?

Controlling the Action

Materials Needed

various art materials such as sheets of foam for building landscape
remote-controlled cars or programmable robots such as a
Lego vehicle and Lego Logo software for a computer
ROBOTIX vehicles and programmable controller, or Valiant Roamer
optional: video camera

What to Do

Before beginning this activity, research a planet like Mars, and then use the information to create a planetary landscape. Use remote-controlled cars or programmable robots to navigate and explore through the terrain. To simulate teleoperation of a remote robot, use a video camera. The camera can be mounted on the robot or on a tripod viewing the whole terrain. Operate your robot using the view on a television monitor. There are Internet sites which permit you to control robots in different parts of the country. Visit the CSC Telerobot robotic site to control our mechanical arm from your computer.

ACTIVITY: 4 DESIGN A SOFT LANDER

When exploratory probes land on other planets, they must touch down softly. Otherwise, they can become multimillion-dollar garbage heaps!

Form teams of two Mission Team Members each. Use a raw eggs to represent the delicate instrumentation of a planetary lander. Build a cushion around the egg that prevents the egg from breaking when dropped from a predetermined height. You can build the cushion from materials that may include but are not limited to: Styrofoam "noodles," bubblewrap, cardboard, balloons and plastic containers. Teams can conduct a contest to see which eggs survive landings from successively higher drops.

QUESTIONS for advanced thinking

Development of every new technology raises questions that we, as individuals and as a society, need to address. Will this technology help me become the person that I want to be, or that I should be? How will it affect the principle of treating everyone fairly? Does the technology help our community advance our shared valuesThis section contains four questions examining robotics and ethics. Each question contains audio responses collected from **researchers**, **scientists**, **labor**

If in the future machines have the ability to reason, be self-aware and have feelings, then what makes a human being a human being, and a robot a robot?would you? And if so, how do you think this might affect you as a person?Are there any kinds of robots that shouldn’t be created? Or that you wouldn’t want to see created? Why?

Automation and the development of new technologies like robotics is viewed by most people as inevitable. But many workers who lose their jobs consider this business practice unfair. Do you think the development of new technologies, and their implementation, is inevitable? What, if anything, should we as a society do for those people who lose their jobs?

Robotics on the Web

Angus' Robotics Site
Angus' Robotics Site is the creation of a young English Mission Team Member who has been a robotics enthusiast since he was six years old. The site features robotics projects illustrated with photographs. Visitors can download robot related utilities or check out resources and robotics links.
http://www.botic.com/users/angus/

Robohoo!
This site is an online resource for robotics fans. Features include hardware and software, robotics competitions, organizations, along with an online store for robotics books and components.
http://www.robohoo.com/

RobotCafe
People who are just getting started with robotics can find useful links to stores, competitions, organizations and clubs, toys, robotics cartoons, and hardware and software.
http://www.robotcafe.com/

The FIRST Robotics Competition
The FIRST Robotics Competition is a national engineering contest for high school Mission Team Members. The site provides information on the six-week program concludes with tournaments held in fifteen locations. The competition fosters partnerships between schools, businesses, and universities and encourages young people's interest in science and engineering.
http://www.usfirst.org/2001comp/

FIRST LEGO League
Each year the FIRST LEGO League announces a new challenge highlighting a current scientific or technological problem facing the world. Mission Team Members are invited to work in tams to build, program, and test their own fully-autonomous robots. The site provides all the information needed to participate in the competition which is based on the belief that kids learn best when they work together to construct something that they find personnally meaningful.
http://www.legomindstorms.com/fll/

KISS Institute for Practical Robotics
The KISS Institute of Practical Robotics is a non-profit organization that provides learning and skill development through the application of technology, particularly robotics. The site features the High School Botball Robotics Tournament, robotics courses for Mission Team Members, and educational resources. http://www.kipr.org/

Society of Manufacturing Engineers
The Society of Manufacturing Engineers offers information on robotics for Mission Team Members on their site. Activities include national robotics challenges with a division for middle school Mission Team Members.
http://www.sme.org/

National Engineering Design Challenge

The National Engineering Design Challenge encourages teams of high school Mission Team Members to work in teams with engineering advisors to design, fabricate, and demonstrate working solutions to a social need. The site is sponsored by JETS, the Junior Engineering Technical Society, with the goal of guiding high school Mission Team Members towards college and careers in engineering.
http://www.jets.org/nedc/nedc.htm

GoRobotics

This site provides resources for robotics, including projects, books, and links to other robotics sites. http://www.gorobotics.net/